PB82-106899

Mobile Chemical Company, South Fort Meade Mine Polk County, Florida: Supplemental Information Document

Engineering-Science, Inc.
Atlanta, GA

Prepared for

Environmental Protection Agency
Atlanta, GA

Sep 81

U.S. Department of Commerce
National Technical Information Service
NTIS

United States
Environmental Protection
Agency

Region 4
345 Courtland Street, NE
Atlanta, Ga 30365

EPA 904/9-81-075a
September, 1981

PB82-106899

EPA

Environmental Impact Statement

Draft

Mobil Chemical Company South Fort Meade Mine Polk County, Florida

Supplemental Information Document

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

BIBLIOGRAPHIC DATA SHEET

1. Report No. EPA 904/9-81-075 a

2.

3. Recipient's Accession No. PB82 106899

4. Title and Subtitle
Mobil Chemical Company, South Fort Meade Mine, Polk County, Florida Draft Environmental Impact Statement
Supplemental Informational Docuemnt

5. Report Date September, 1981

6.

7. Author(s) EIS Preparation Section, EIS Branch, S&A Division

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Engineering-Science, Inc.
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10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address
U.S. Environmental Protection Agency
Region IV
345 Courtland Street, N.E.
Atlanta, Georgia 30365

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstracts

Mobil Chemical Company has proposed an open pit phosphate mine, beneficiation plant and transshipment facility on a 16,288-acre site in southern Polk County, Florida. Mining would involve 15,194 acres, all of which would be reclaimed, and would produce 77 million tons of phosphate products over a 25-year period. The EIS examines alternatives, impacts and mitigative measures related to air, geology, radiation, groundwater, ecology and other natural and cultural systems.

17. Key Words and Document Analysis. 17a. Descriptors

Mobil Chemical Company
phosphate mine
Polk County
Florida
air
geology
radiation
groundwater
ecology

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Availability Statement

19. Security Class (This Report) UNCLASSIFIED

20. Security Class (This Page) UNCLASSIFIED

21. No. of Pages

22. Price

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DATE: SEPTEMBER 14, 1981

SUBJECT: Items to be Submitted to NTIS

FROM: Carolyn Mitchell
Head Librarian

TO: Documents Input Liaison Section
National Technical Information Service

Attached are 11 copies of the Draft EIS Mobil Chemical Company, South Fort Meade Mine, Polk County, Florida EPA report numbers 904/9-81-075 and 904/9-81-075a which are submitted through my office, EPA Region IV (EPAEKA).

Because we have met the NTIS requirement of 11 copies, no input charges should be deducted from our account.

Thank You!

DRAFT

ENVIRONMENTAL IMPACT STATEMENT

SUPPLEMENTAL INFORMATION DOCUMENT

Mobil Chemical Company
South Fort Meade Mine
Polk County, Florida

September, 1981

Prepared For: U.S. Environmental Protection Agency
Region IV
345 Courtland Street, N.E.
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1.a

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1.0 INTRODUCTION

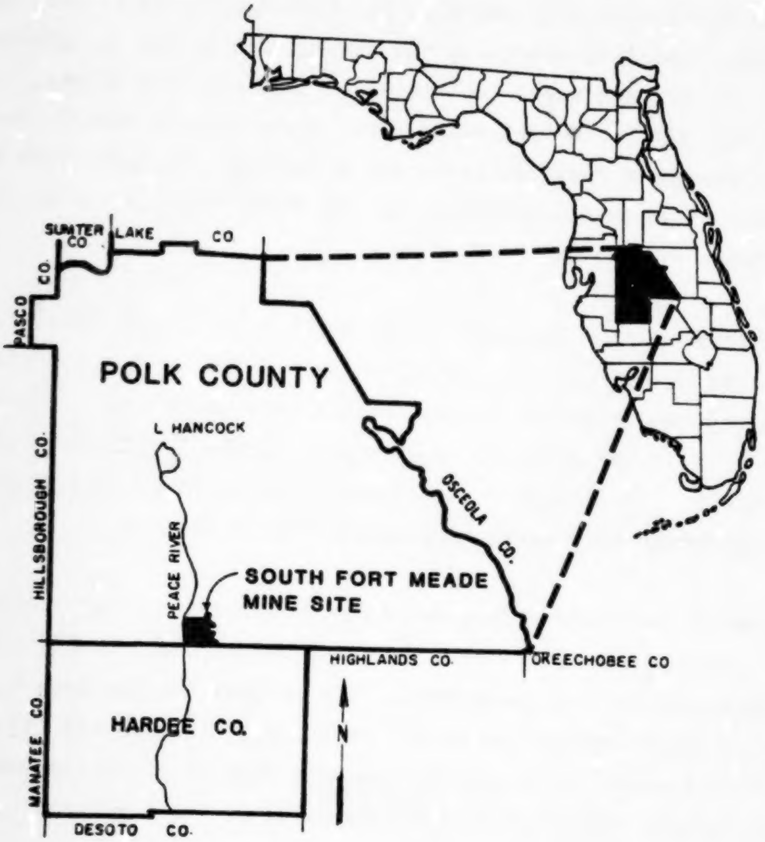
Mobil Chemical Company mines, processes and ships phosphate ore in the central Florida area. Mobil currently operates the Fort Meade mine located in Polk County, Florida. Mobil is proposing the development of new phosphate mining, beneficiation and transshipment facilities in southern Polk County, Florida. The new facility, the South Fort Meade Mine, would replace Mobil's Fort Meade Mine when the phosphate reserves there are depleted. The South Fort Meade Mine would be located on approximately 16,300 acres lying ten miles southeast of the Fort Meade Mine (Figure 1-A, 1-B).

This new facility would allow Mobil to maintain a continuous supply of phosphate ore to its customers. The annual production of the proposed facility, at full capacity, would be 3.4 million tons of phosphate rock. The development would result in the disturbance of approximately 15,200 acres of the 16,300-acre tract. The proposed mining operation would produce 77 million tons of wet phosphate rock over the 25-year life of the mine.

This Supplemental Information Document (SID) has been prepared as part of the supporting technical data and evaluations related to the U.S. EPA's EIS for Mobil's Proposed South Fort Meade Mine. The information has been compiled in the form of an SID to reduce the length of the EIS, to make the EIS more analytical than encyclopedic, to highlight the most significant environmental concerns and to make the EIS more understandable to the non-technical public.

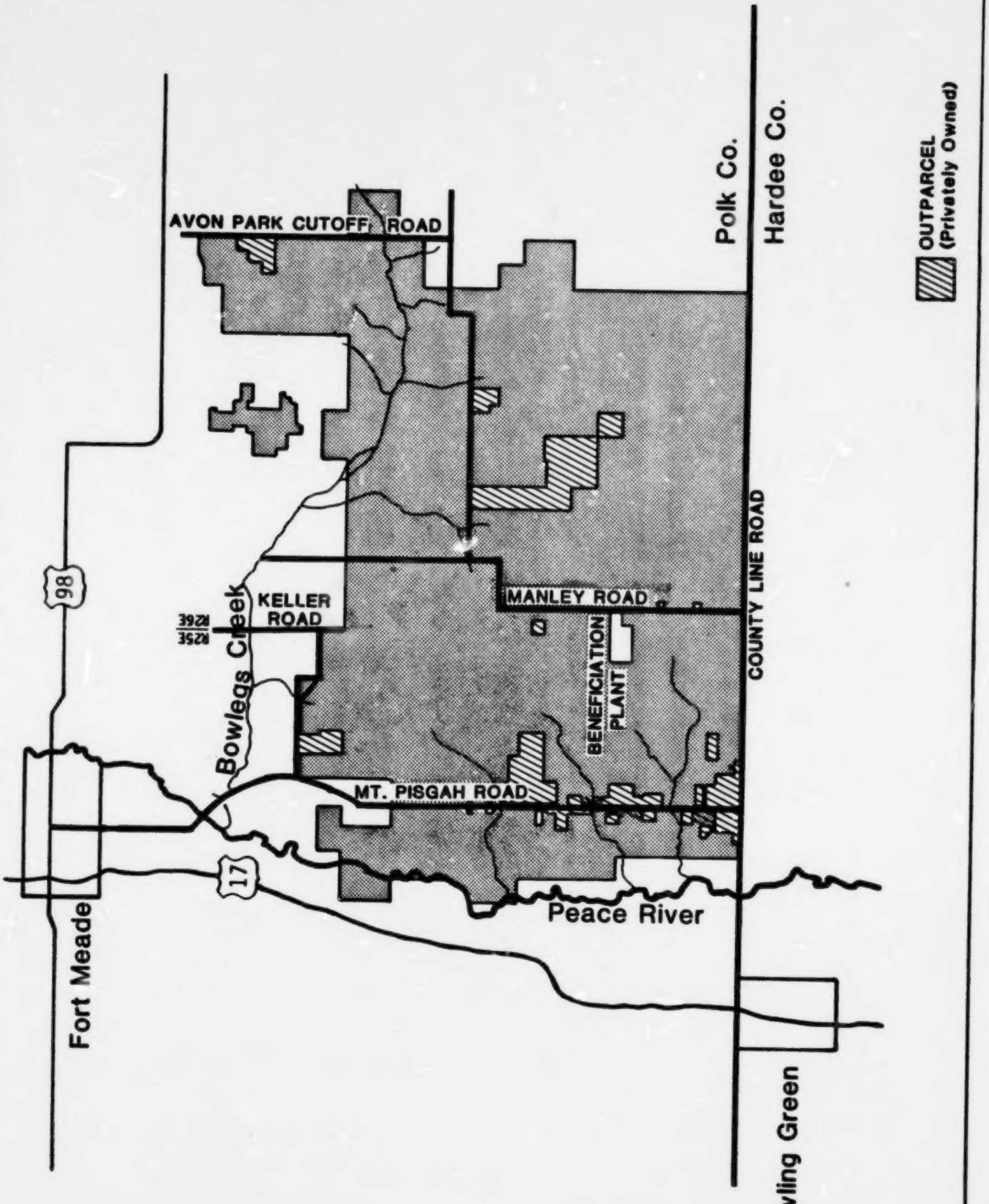
FIGURE 1-A

LOCATION OF PROPOSED SOUTH FORT MEADE MINE SITE



SOURCE: MOBIL

SPECIFIC SITE LOCATION OF PROPOSED SOUTH FORT MEADE MINE



SOURCE: MOBIL

2.0 THE PROPOSED ACTION

2.1 INTRODUCTION

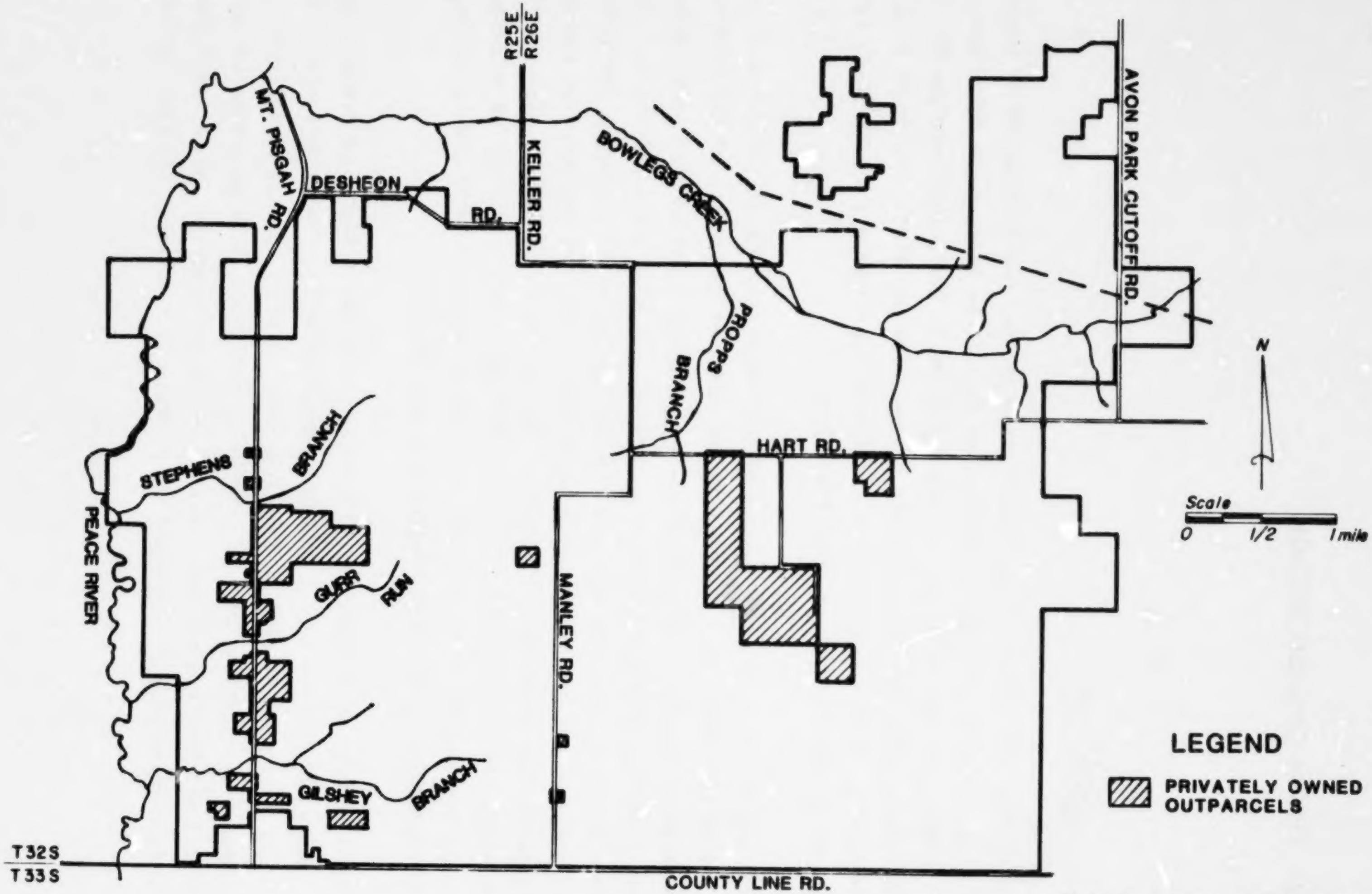
Mobil Chemical Company, Inc. (Mobil) is proposing the development of phosphate mining, beneficiation and transshipment facilities in southern Polk County, Florida. The new facility, the South Fort Meade Mine, would replace Mobil's Fort Meade Mine when the phosphate reserves are depleted. The South Fort Meade Mine (Figure 2-A) would be located on approximately 16,300 acres lying ten miles southeast of the Fort Meade Mine.

The proposed mine operation would disturb approximately 15,194 acres or 93 percent of the site. Approximately 13,340 acres or 88 percent of the disturbed acreage is scheduled for actual mining. Another 1,854 unmined acres would be disturbed by various activities associated with mining and processing. Of that total, 1,320 acres are required for initial waste disposal, 124 acres are occupied by ore processing and support facilities, and 410 acres of unmined setbacks from property boundaries and public rights-of-way are disturbed by adjacent mining and waste disposal activities. Existing land use patterns would continue on reserve lands until those lands are scheduled for mining. Approximately 1,094 acres would remain undisturbed.

Mobil's South Fort Meade mining operation has been designed to produce approximately 3.4 million tons of phosphate rock annually. The mine would be developed in two phases with Phase I scheduled to start up in 1984 following a 21-month construction period. Phase I operations, with an estimated capacity of 1.7 million tons per year, would require one dragline and an associated beneficiation plant. The start up of Phase II is planned for 1987 following a

FIGURE 2-A

PROPOSED SOUTH FORT MEADE MINE SITE



Mobil is currently negotiating for purchase of selected outparcels.

similar 21-month construction interval. Facilities comparable to Phase I would be developed in Phase II, increasing ultimate production capacity to 3.4 million tons per year.

Equipment and procedures similar to those presently used in Mobil's two Florida phosphate mines are proposed for the new facility. When in full production, two large walking draglines would operate simultaneously, mining and extracting phosphate ore from separate areas. The ore would then be slurried and hydraulically transported in pipelines to a central washing facility for disaggregation and recovery of phosphatic pebble. Sand-sized phosphatic particles would be concentrated by flotation methods. Wet rock would be stored in on-site stockpiles or loaded directly onto railroad cars for transport to Mobil's existing drying facilities in Nichols, Florida. Residual clay and sand waste products would be redeposited on the property in two forms: clay impoundment areas and sand tailings backfill areas (Figure 2-B).

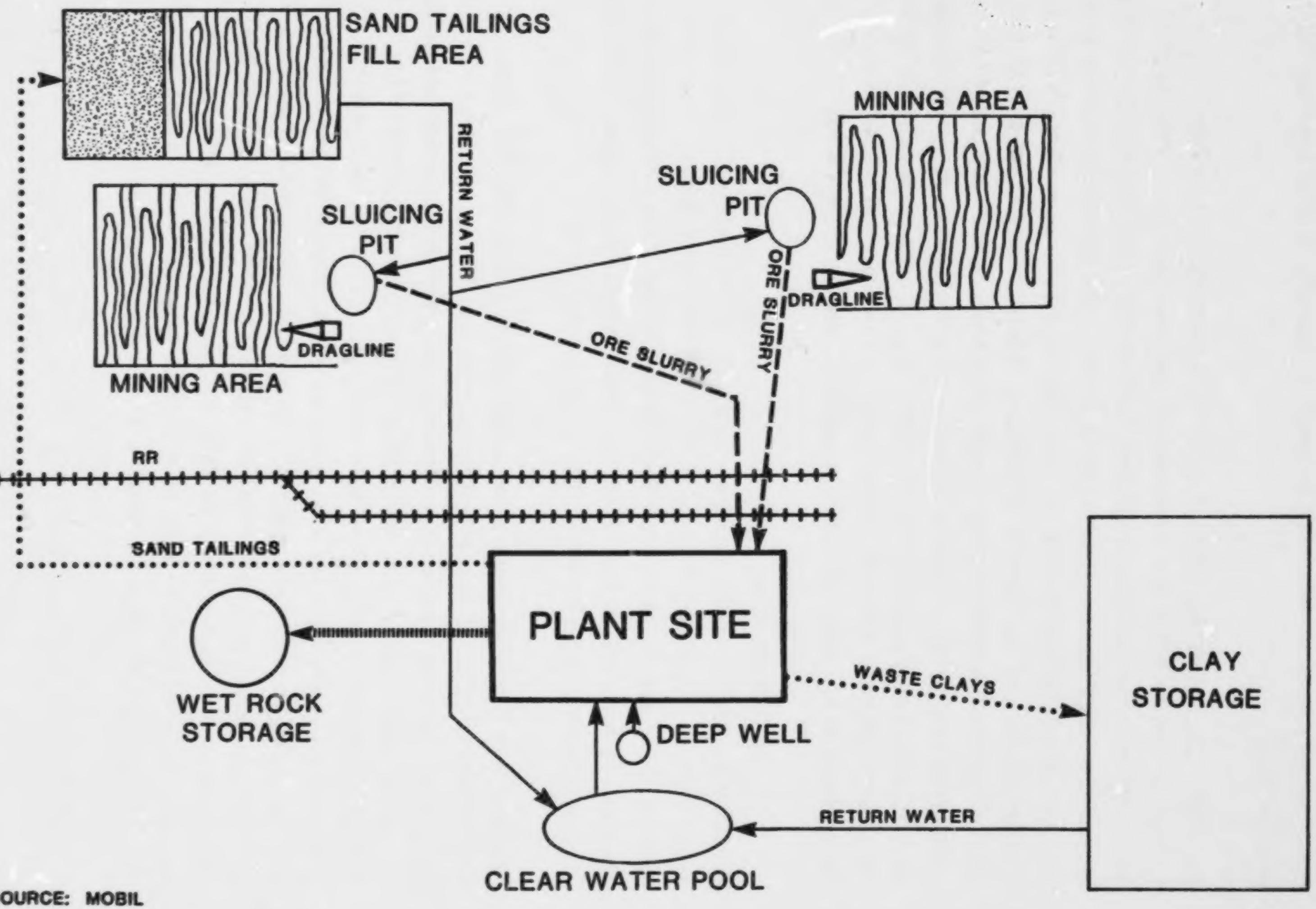
2.1.1 PRESERVED AREAS

Figure 2-C identifies the three areas preserved from mining. The preserved areas include a 900-foot wide corridor along the Peace River, a corridor along Bowlegs Creek approximately 660 feet in width, and a unit centrally located on the eastern boundary of the property. These areas occupy about 1,090 acres, or approximately 6.7 percent of the total surface area.

The corridor along the Peace River comprises approximately 583 acres, of which approximately 30 acres are classified as wetlands. Another 427 acres are classified as transition mesic. The remaining acreage is comprised of pasture or upland cover types. The Peace River transition mesic association is among the most valuable of the property's habitats. It is the most diverse of the transected forests on site, having the greatest Shannon-Weaver diversity and the largest number of tree species. It also has the second highest tree density and coverage (basal area) of the habitats in the preserved areas. Sensitive plant species would be left wherever they occur within undisturbed areas. The site would be open to qualified individuals or groups to remove and preserve protected plant species provided all applicable Mobil safety re-

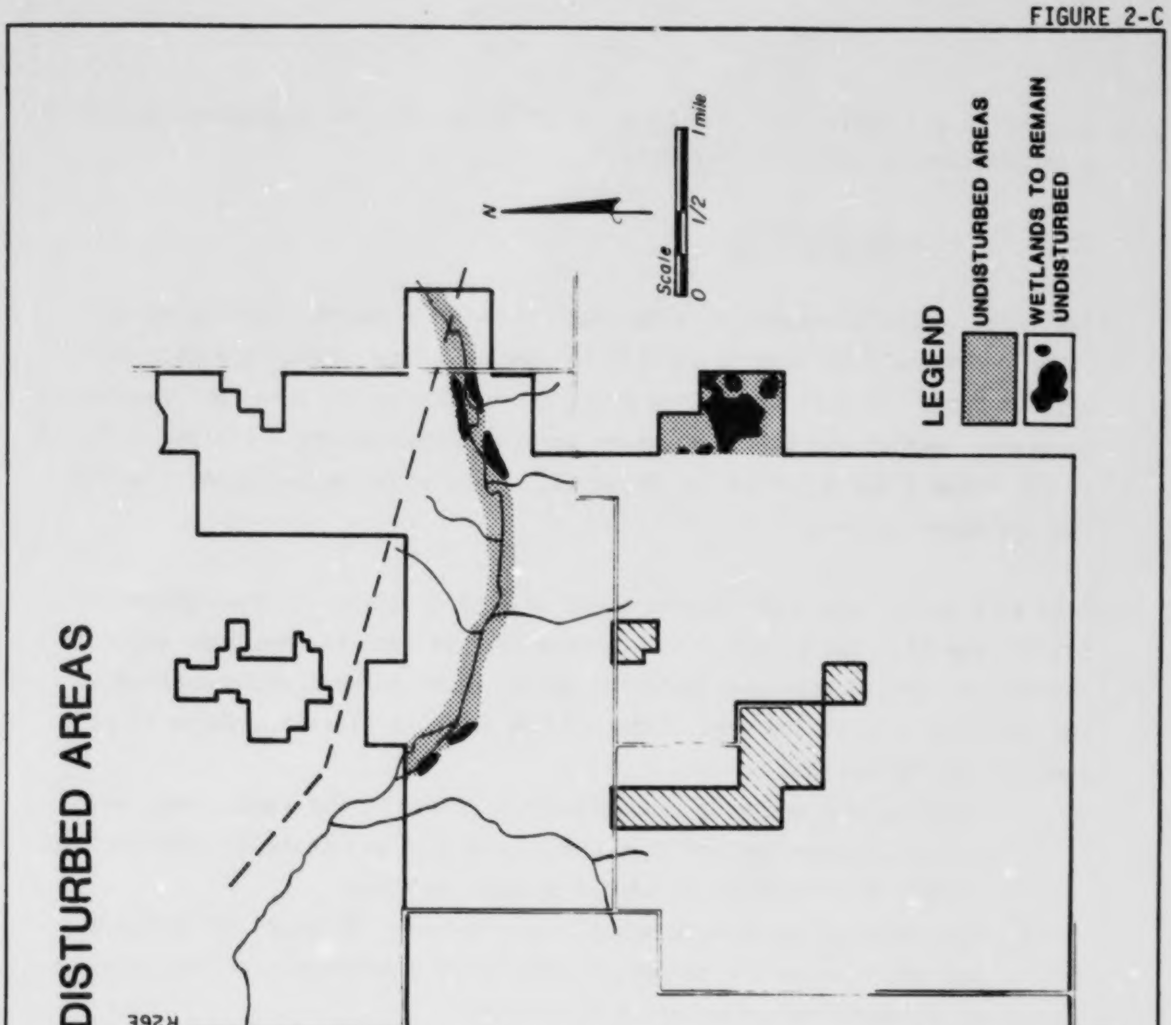
FIGURE 2-B

CONCEPTUAL DIAGRAM OF MINING & WASTE DISPOSAL



SOURCE: MOBIL

FIGURE 2-C



UNDISTURBED AREAS

SOURCE: ZELLARS-WILLIAMS

quirements are satisfied. The location of three relatively uncommon sensitive plant species is depicted in Figure 2-D.

2.2 MINING OPERATION

Two large electric-powered walking draglines with a bucket capacity of 45-cubic yards would be used to sustain an average annual production rate of 3.4 million tons. At this production rate, approximately 725 acres per year would be mined. Annual energy requirements for the draglines are estimated at 1,650 kW for Phase I and 3,300 kW for Phase II. Power would be purchased from the Florida Power Company.

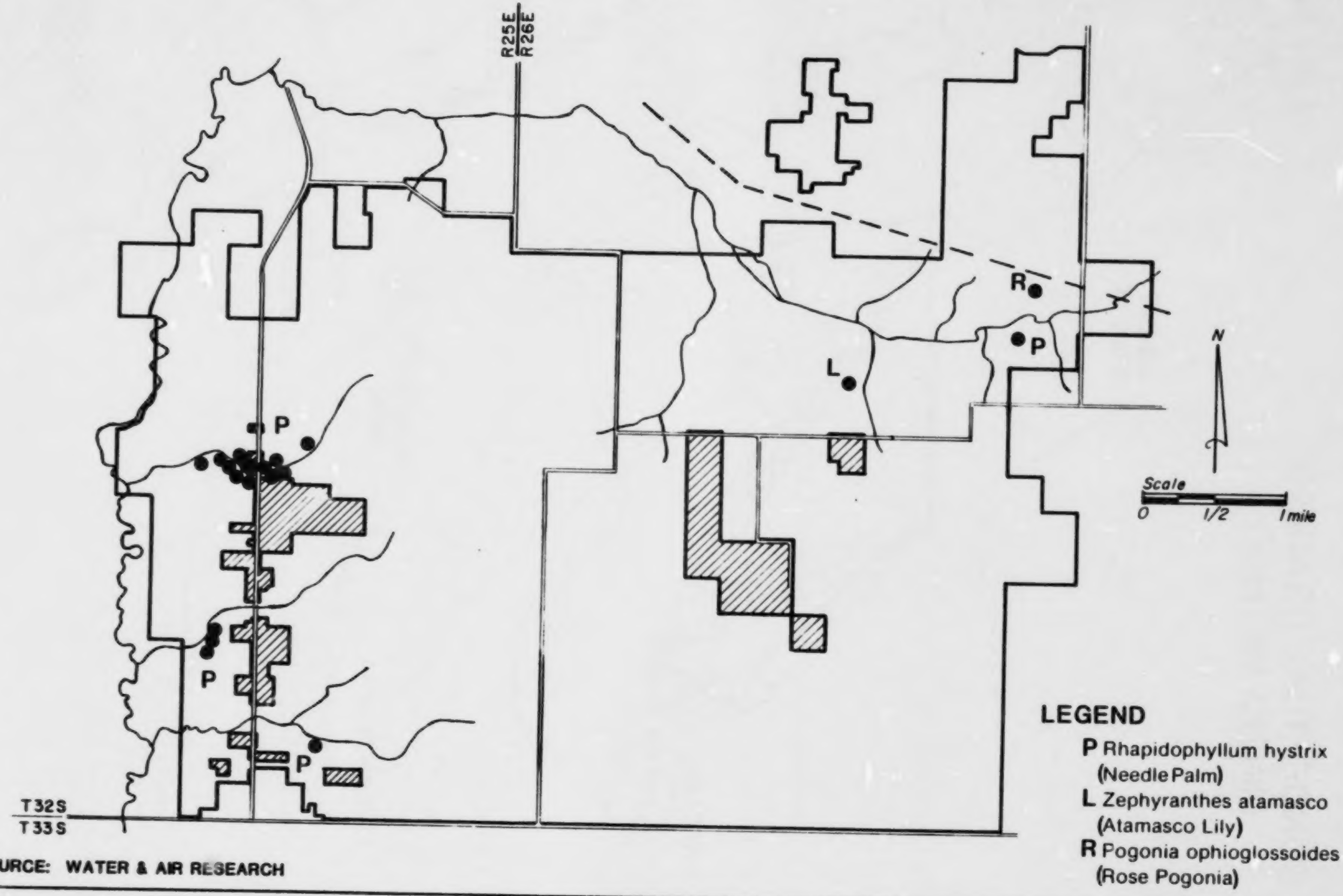
A 50-acre parcel would be cleared ahead of each dragline and the vegetative debris from clearing burned. To minimize adverse impacts from open burning during the construction and operation phases, open burning would conform to the applicable rules and regulations of the State of Florida. These rules specify the following:

- Open burning would be conducted in a manner, under conditions, and within certain periods that would reduce or eliminate the deleterious effect of air pollution caused by open burning.
- Open burning would be conducted only between the hours of 9:00 a.m. and one hour before sunset, or upon direct permission of the Division of Forestry for other hours of the day.
- The size, moisture content, and composition of the refuse piles would be such as to minimize air pollution and ensure that all burning would be completed within the allowable time period.

Each dragline would mine by digging a series of parallel cuts approximately 330 feet wide and up to one mile long (Figure 2-E). The dragline would then strip the overburden above the ore and cast the spoil into a previously mined cut. After an adequate quantity of ore is uncovered, it would be excavated by the dragline and dumped into sluicing pits where the ore would be slurried by high pressure water guns.

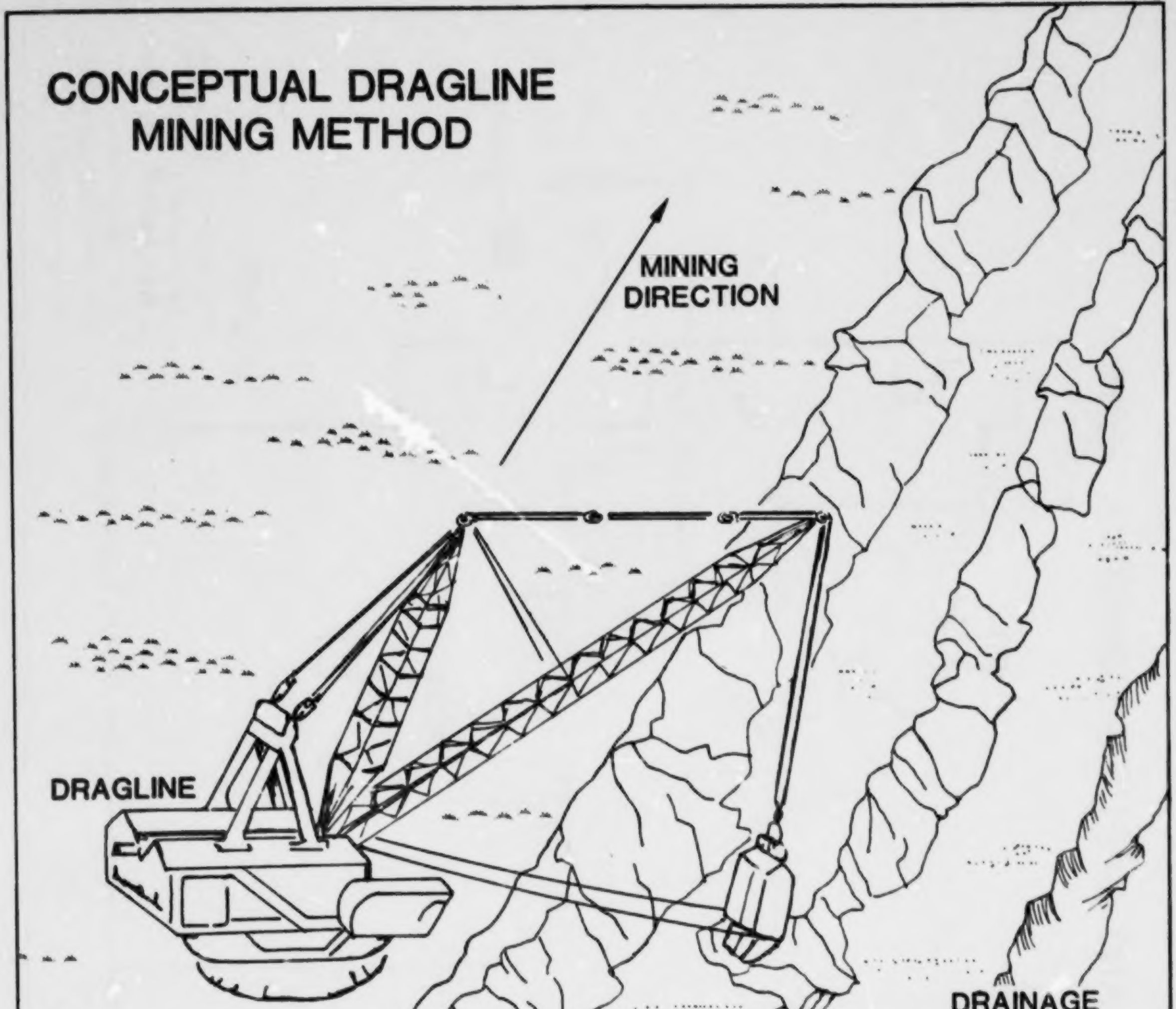
FIGURE 2-D

SENSITIVE PLANT SPECIES OBSERVATIONS


R25E
R26E
T32S
T33S
P
P
P
L
R
P
N
Scale
0
1/2
1 mile
LEGEND
P Rhapidophyllum hystrix (Needle Palm)
L Zephyranthes atamasco (Atamasco Lily)
R Pogonia ophioglossoides (Rose Pogonia)

SOURCE: WATER & AIR RESEARCH

FIGURE 2-E



CONCEPTUAL DRAGLINE MINING METHOD

SOURCE: MOBIL

Mobil proposes to utilize pocket-toe spoiling, a leach zone management technique in which overburden from near the interface with the matrix is placed in a pocket at the toe of the spoil pile and covered with overburden from the upper strata. This technique confines the distribution of potential leach zone material to a level below its present on-site location.

Operating constraints would require dewatering the Surficial Aquifer, temporarily lowering water levels adjacent to the mine pit. A drawdown of one foot is expected 115 feet from the perimeter of the open pit. To minimize the drawdown influence, Mobil proposes to utilize perimeter rim ditches for recharge at property boundaries and designated sensitive areas. Adjacent to Bowlegs Creek and the Peace River, water-filled rim ditches would be maintained between open mine pits and preserved wetlands to prevent temporary dewatering. The mine pits would be filled with sand or clay wastes in aqueous suspension after mining to assist in re-establishing the water table. Reclaimed areas adjoining all preserved wetlands would be at or above existing grade. Preserved wetlands would, therefore, continue to occupy topographic depressions and receive surface runoff from surrounding areas.

Any runoff from areas cleared for the plant and ancillary structures would be captured by perimeter ditches. These ditches would be connected to the active mine water recirculation system, where suspended solids are removed. The plant area would be landscaped as soon after construction as possible to reduce erosion potential.

As land is cleared for mining (approximately 530 acres a year), runoff will be directed either to shallow ditches or directly into mine pits and from there into the water recirculation system. Following mining, the majority of the mined land would be used for disposal of sand and clay wastes. Waste disposal areas would be either below grade or enclosed by dams. After dam construction these areas would be encircled by ditches to collect and route turbid runoff to the water recirculation system. A vegetative cover would be established on the dams as soon as possible to stabilize the slopes and prevent erosion. While waste disposal areas are active, portions of the interior would be devoid of vegetation; however, the wind erosion potential is low since the wastes are deposited in aqueous suspension. Any turbid runoff resulting from erosion of protruding overburden piles within waste disposal areas would be contained with the disposal areas and routed to the mine water recirculation system. Discharges from the water recirculation system would be closely monitored to ensure main-tenance of all applicable water standards.

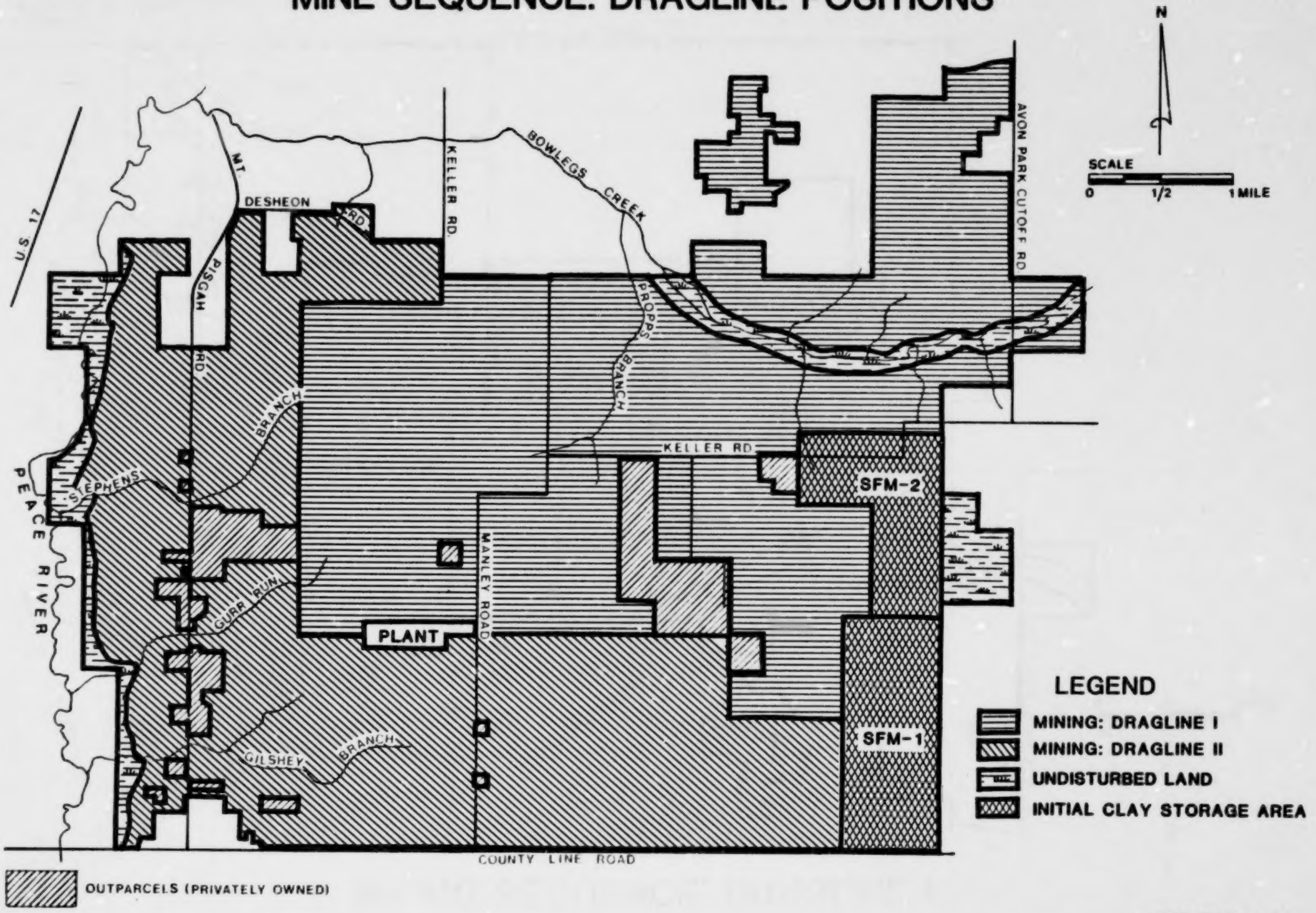
A buffer zone of vegetation would be left near the two major watercourses to help control any turbid runoff from sites not enclosed by dams. During reclamation, land near these watercourses would be revegetated as rapidly as possible following final grading. Special measures such as the use of hay mulch and interseeding with fast-growing temporary forages such as rye or millet would be used in these critical areas. Watersheds of the minor tributaries would be graded and revegetated before they are opened to the regional system. In addition, the proposed reclamation plan includes creation of marsh areas near the intersection of the restored creekbeds with their undisturbed counterparts. These marshes would help remove suspended sediments and excess nutrients before the drainage water is released into the regional system.

To gain access to mining parcels north of Bowlegs Creek, a dragline crossing would be located at an existing ford. Bowlegs Creek is scheduled to be crossed in 1999 to mine north of Bowlegs Creek and at the same location again in 2002 when mining north Bowlegs Creek is completed. Both times the crossings would occur during low flow periods. Woody vegetation in the corridor to the crossing would be cleared to about twice the width of the dragline and a culvert would be placed in the creek with earth backfilled around it. After each crossing, grass cover would be established to prevent erosion and runoff in the cleared corridor. After the second crossing in 2002, the culvert would be removed and the stream would be re-established. Tree species characteristic of wetlands would be planted to supplement the grass cover in the corridor.

Mining operations would be scheduled on an around-the-clock basis, seven days a week, dependent on production levels and sales requirements. The mining sequence, illustrated in Figures 2-F, G and H, is proposed to continue for 25 years with reclamation activities extending 10 years beyond the life of the mine. Each dragline would follow a sequence which balances production and grade requirements and facilitates water recirculation, waste disposal and

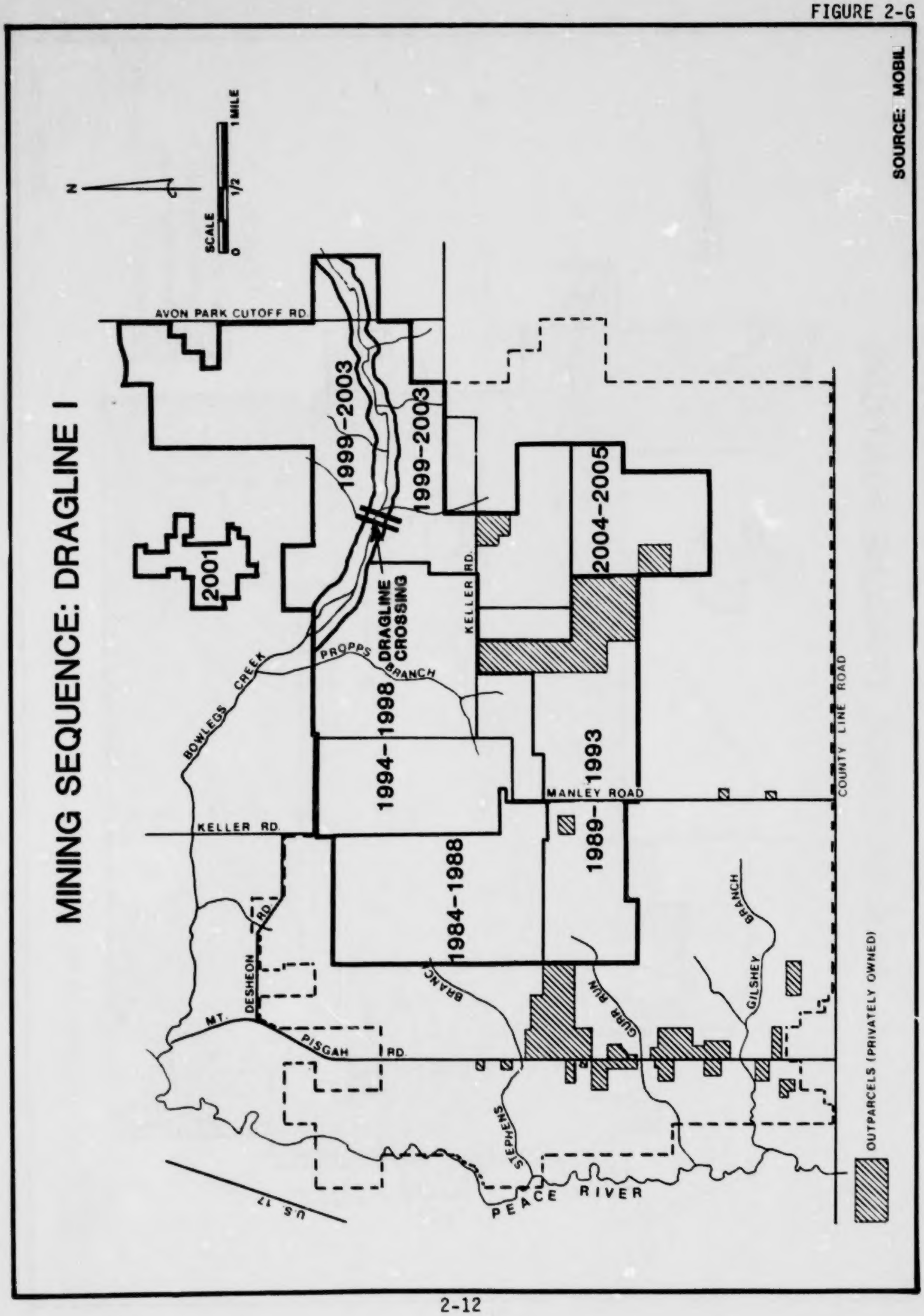
FIGURE 2-F

MINE SEQUENCE: DRAGLINE POSITIONS



SOURCE: MOBIL

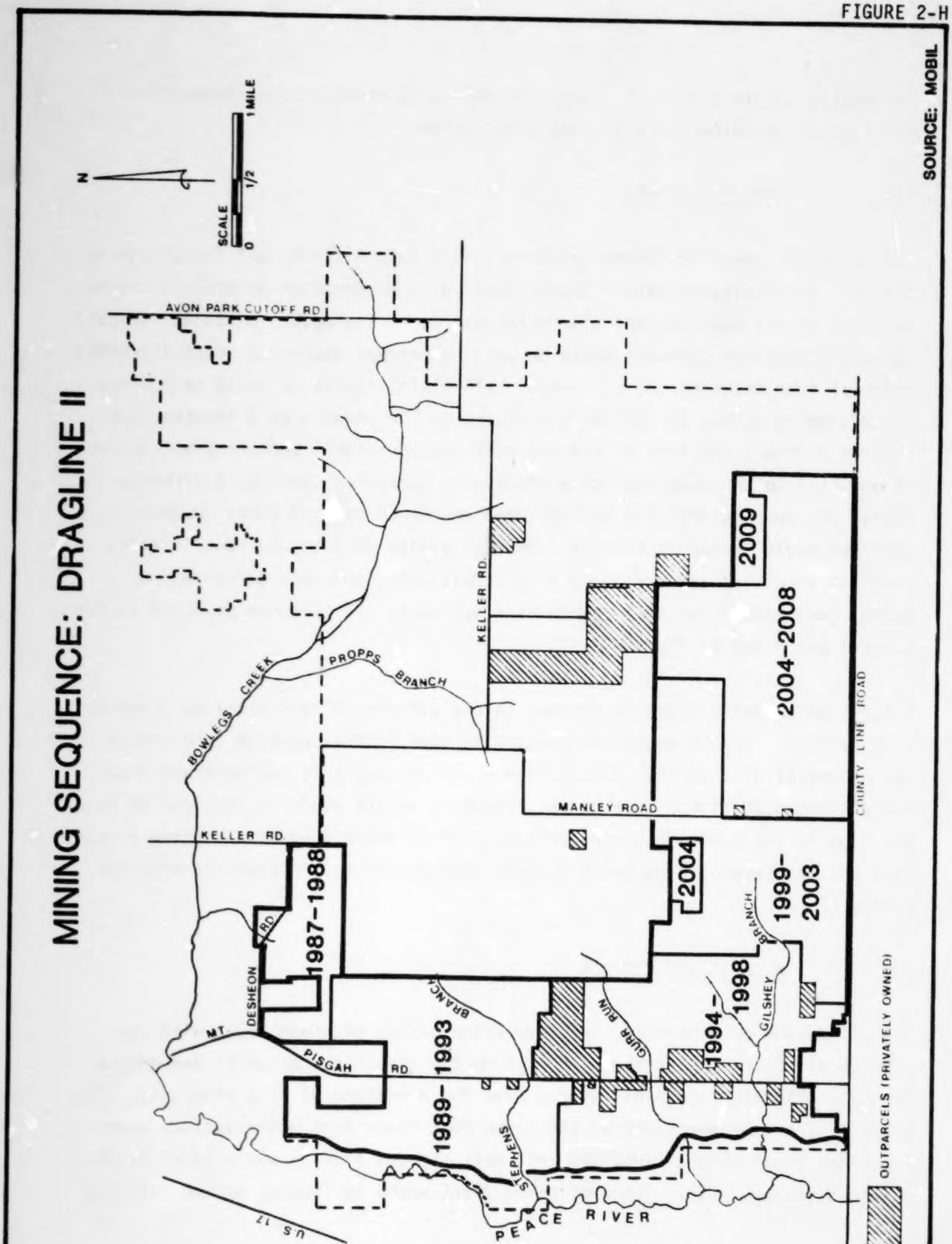
FIGURE 2-G



MINING SEQUENCE: DRAGLINE I

SOURCE: MOBIL

FIGURE 2-H



MINING SEQUENCE: DRAGLINE II

SOURCE: MOBIL

reclamation activities. If production and sales requirements change, the duration of the mine operation may also change.

2.3 MATRIX TRANSFER

The mined ore would be dumped by the dragline into a slurry pit for disaggregation. Recirculation water (18,750 gpm) would be directed by hydraulic guns to break up the material and slurry the matrix to a pumpable mixture. Grizzly screens (large bar screens) would be used to prevent oversized rocks and other material from entering the pit pump. Each mining operation would have a separate pumping system to deliver the slurry to the plant with a booster pump located within 1,500 feet of the pit pump and additional booster pumps spaced at one-half to three-quarter mile intervals, depending upon the difference in elevation, pumping distance and the head developed by each pump. An 18-inch pipeline would transport the ore from each mining area to the beneficiation plant at a rate of approximately 1,200-cubic yards per hour per pipeline. Energy consumption for the ore transfer system is estimated to be 4,800 kW for Phase I and 7,100 kW for Phase II.

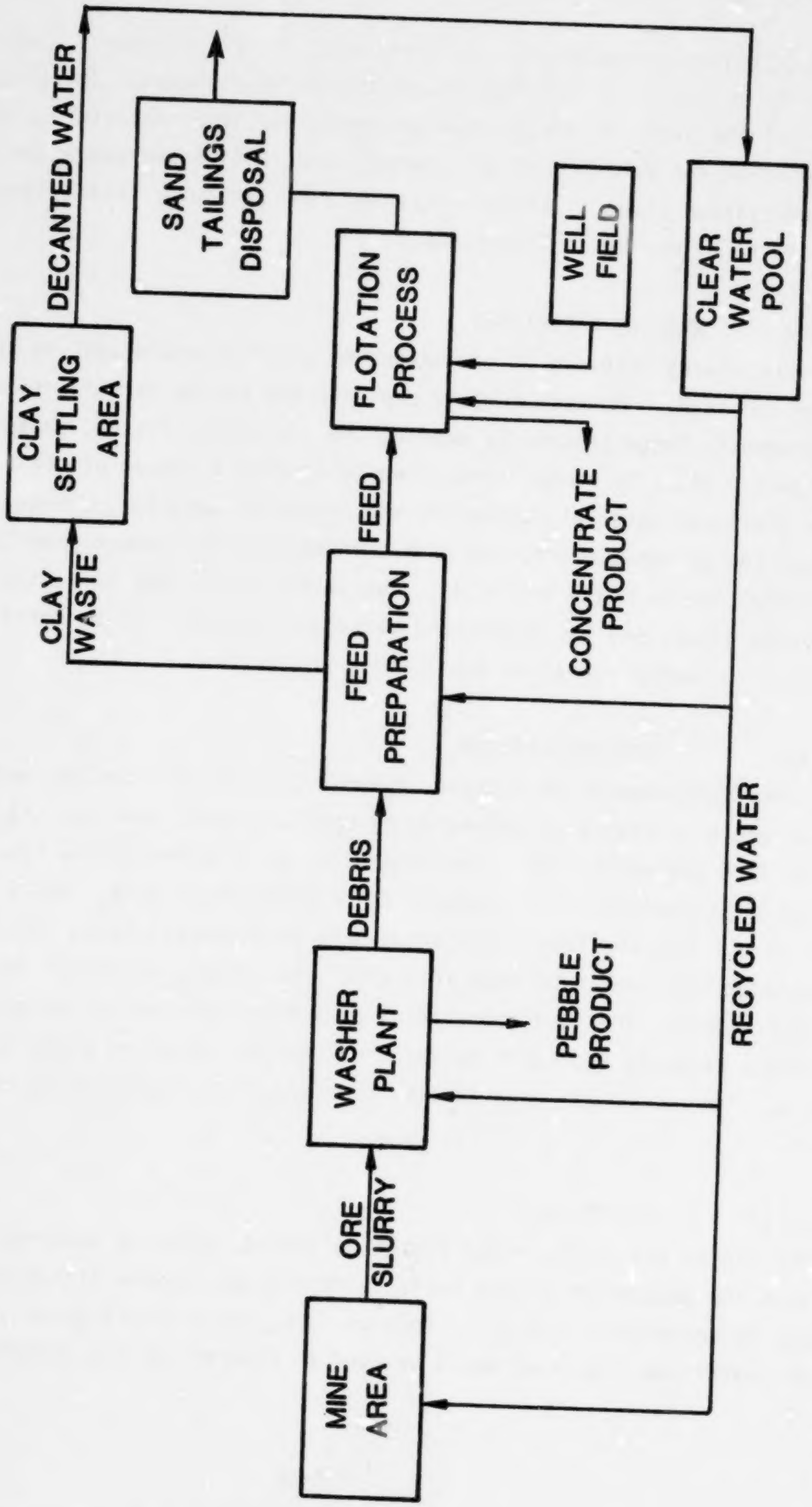
A pipeline crossing would be located in the vicinity of the dragline crossing (Figure 2-G). Double-walled pipe would be used at the crossing to minimize the potential of a spill. Any leakage would be caught in the external pipe and collected at either side of the crossing; valves would be provided to shut off flow in the event of a pipe failure. Mobil would conduct a routine inspection and maintenance program to prevent leakage and spills from the pipeline system.

2.4 PROCESS DESCRIPTION

The processing of phosphatic ore involves a number of steps, each with the purpose of separating phosphate rock from the associated organics and gangue minerals (limestone cobbles, quartz sand and a mixture of clay minerals). The major processing operations at the South Fort Meade Mine would include washing, feed preparation, flotation, wet rock product storage and product transshipment (Figure 2-I). The processing plant would be located at the centroid

FIGURE 2-I

GENERALIZED PROCESS FLOW SHEET



SOURCE: MOBIL

of pumping distances on the site (the most energy-efficient location), adjacent to an existing road that would provide easy access. The proposed location of the plant is now an area presently utilized as pasture with minimal vegetation and wildlife value. During construction and operation of the beneficiation plant, fugitive emissions from vehicular traffic would be minimized by paving the plant roads.

2.4.1 WASHING FACILITIES

The ore slurry received at the washer by pipeline would contain phosphate, clay and sand. The washer would separate the ore by particle size into two components: large phosphatic pebble, and a mixture of sand, phosphate and clay (Figure 2-J). The washer process would involve a number of steps to separate the oversized material, pulverize the oversized material, disaggregate the clays and phosphatic ore, and wash and separate the pebble from the undersized material (waste clays and feed). The pebble would then be routed to wet rock storage piles, and the undersized material (commonly called debris) would be routed to feed preparation for further processing.

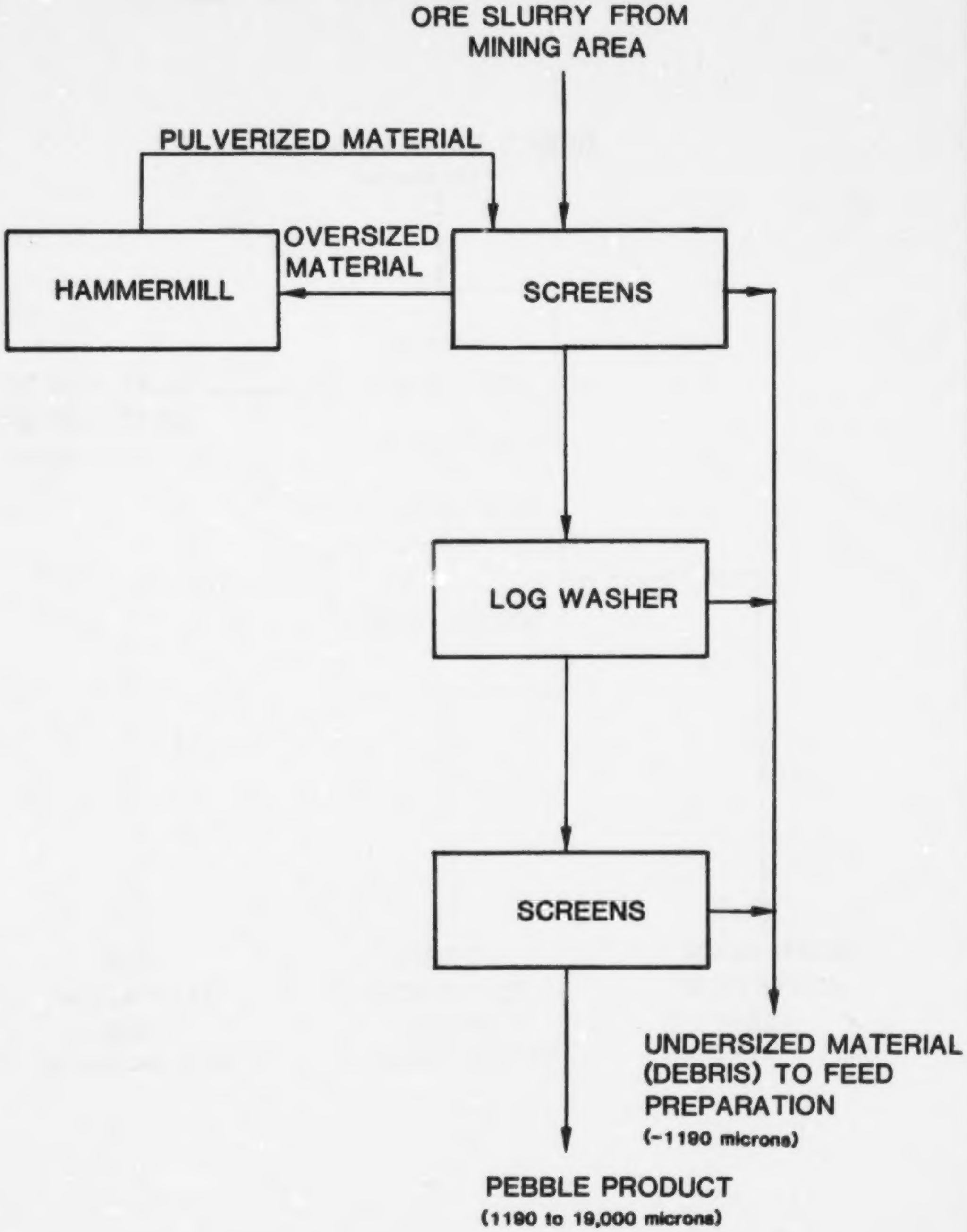
2.4.2 FEED PREPARATION

In the feed preparation process, undersized material from the washing operation would initially be separated by hydro-cyclones into two fractions: flotation feed and waste clay. The feed would be directed to the feed preparation area or stockpiled until required for further processing. Waste clays would be pumped from the feed preparation area to disposal sites. The feed from the hydro-cyclones would be separated into fine, coarse and sizer rock feeds by hydro-sizers. The feed preparation area would provide a limited amount of storage capacity and would deliver feed to the flotation plant at a uniform rate. The conceptual plan for the feed preparation process is shown in Figure 2-K.

2.4.3 FLOTATION

Both single and double stage flotation methods would be employed to concentrate the phosphate (Figure 2-L). Single stage rougher flotation would be used to concentrate the sizer rock product, while double stage flotation of the coarse and fine feed would be used to concentrate the phosphatic sand.

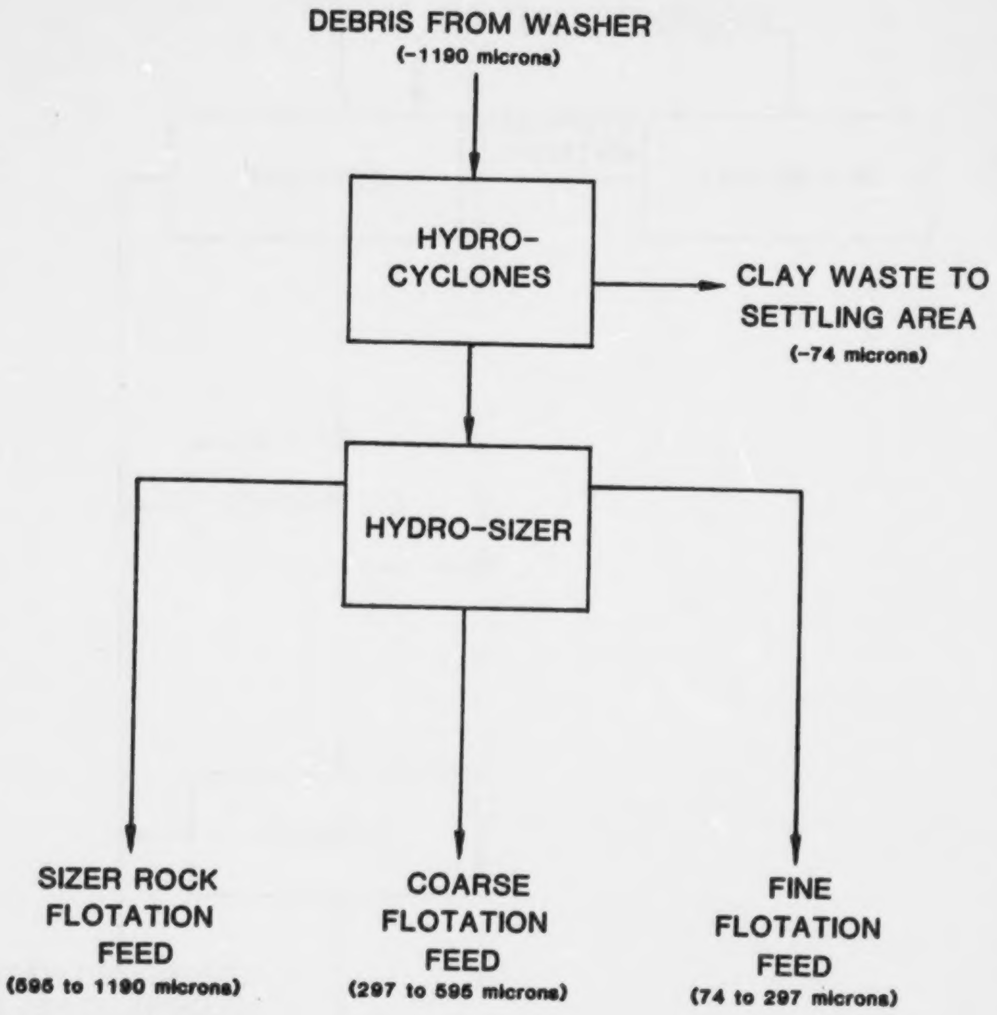
WASHER PROCESS



SOURCE: MOBIL

FIGURE 2-K

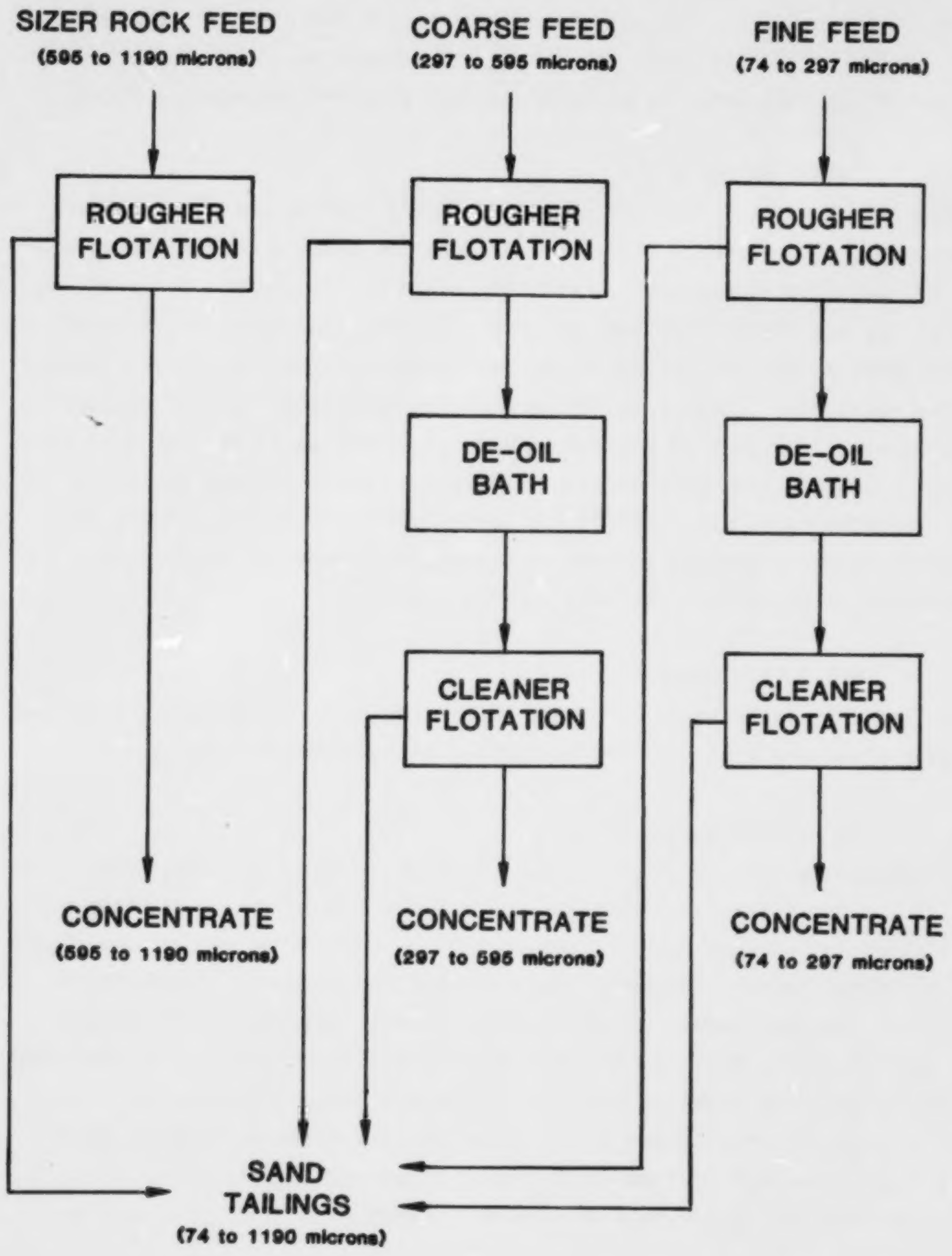
FEED PREPARATION PROCESS



SOURCE: MOBIL

FIGURE 2-L

FLOTATION PROCESS



SOURCE: MOBIL

Rougher flotation would float the phosphatic particles from the sand using fatty acid reagents. The rougher product would then be subjected to a de-oil bath and would be routed to cleaner flotation. The cleaner flotation would utilize amine reagents to float the remaining sand to achieve final concentration of the product. Reagents to be used in the flotation process are listed in Table 2-1. The final phosphate concentrate would be dewatered and held in storage bins prior to transfer to rail cars for shipment to Nichols.

2.4.4 WASTE PRODUCTS

The materials separated from the phosphate during washing and flotation are termed waste. The proposed mine would produce two waste products: clays and sand tailings. Estimated waste quantities would be approximately 132 million tons of clay and 158 million tons of sand tailings. The waste clays would contain about 23 percent of the recoverable phosphate (particle sizes greater than 200 mesh) that state-of-the-art processing technology cannot recover. Approximately 12 percent of the recoverable phosphate would be lost with sand tailings. Conventional beneficiation, therefore, would extract 65 percent of the recoverable phosphate found in the South Fort Meade matrix. Mobil is pursuing a research program to develop processing technology that would allow the recovery of phosphate lost in the waste clays.

2.4.5 WET ROCK STORAGE

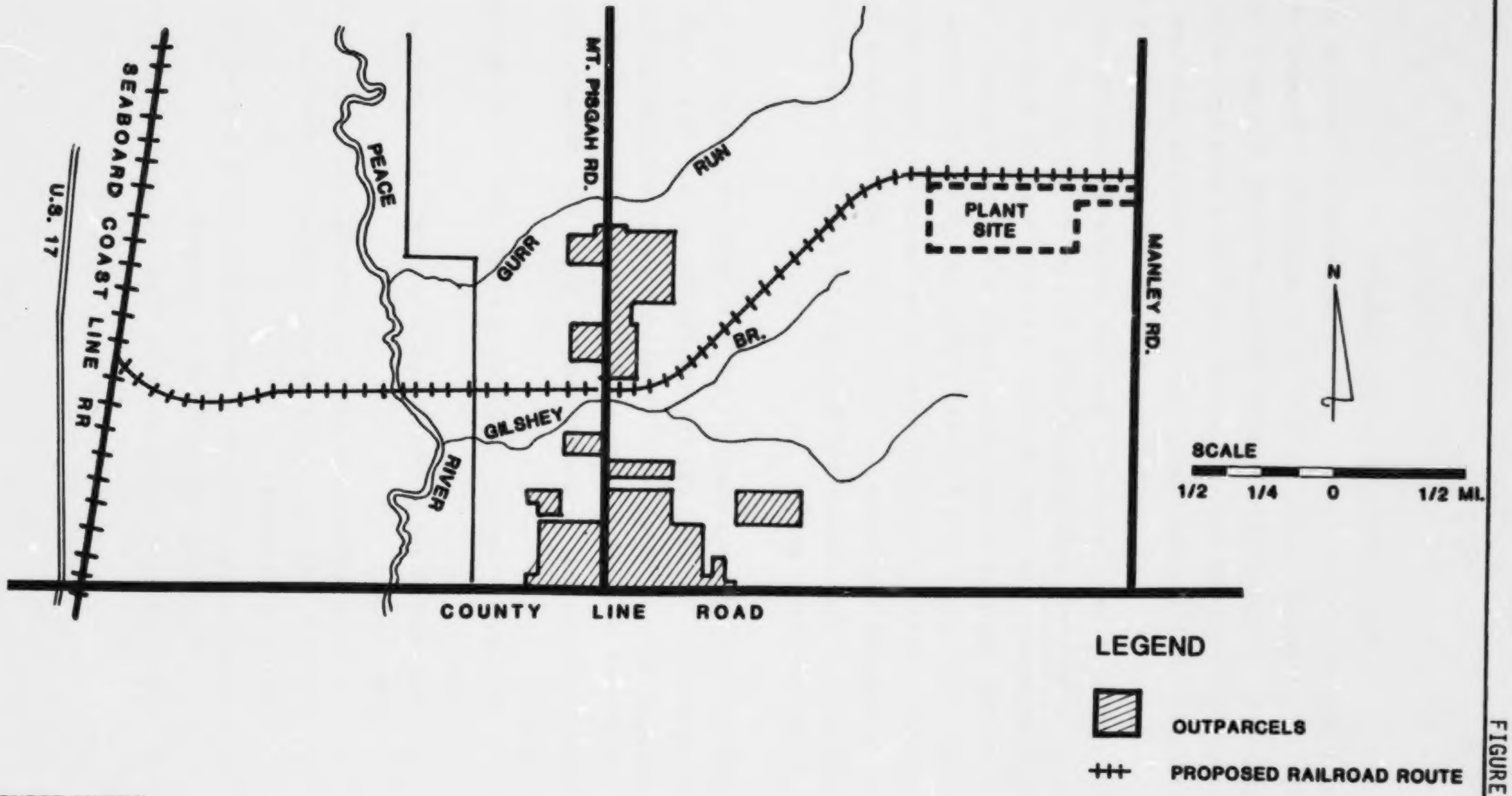
Pebble from the washer would be placed on a surge pile. Concentrate from the flotation plant would be retained in storage bins until transfer.

2.4.6 PRODUCT TRANSPORT

The wet phosphate rock produced at South Fort Meade would be transferred into open top, bottom discharge hopper rail cars for transport to an existing facility at Nichols. During Phase I operations, one train with 33 cars would make two daily trips between the beneficiation plant and Nichols. During Phase II operations, the same number of train trips would be required but the train would have 65 cars. Mobil would construct a six-mile rail spur from the plant site to the existing Seaboard Coast tract (Figure 2-M). A bridge would be built to cross the Peace River and a grade crossing would be required on Mt. Pisgah Road. The rail cars would be pushed twice each day from the beneficiation plant to the main track and returned.

FIGURE 2-M

PROPOSED RAILROAD ROUTE



SOURCE: MOBIL

2.4.7 BULK CHEMICAL/PETROLEUM STORAGE

The flotation reagents listed in Table 2-1 would be stored on site in vertical, cylindrical, steel tanks built on above-ground foundations in a diked tank farm. The surface inside the walled or diked area would be paved and sloped to direct any spillage and/or runoff to a sump pump which would discharge to the flotation plant. Any spillage from the tank farm would be subsequently adsorbed by the clay in the flotation plant sand trap effluent and removed in the clarifier. Gasoline and diesel fuel for vehicles would be stored in separate under-ground tanks located in the vicinity of the main plant warehouse. Gasoline would be stored in a single 5,000-gallon tank and diesel fuel would be stored in two tanks with a total capacity of 10,000 gallons. All applicable Federal, state, and local construction and safety regulations would be strictly observed in the construction and operation of the underground facilities. Lubrication oils would be stored in above ground containers of the capacity and type necessary to service plant and mine equipment and vehicles.

Petroleum storage tanks would be built in accordance with American Petroleum Institute (API) standard 651 for atmospheric tanks. Tanks would be vented in accordance with API standards. A retaining wall surrounding the tanks would be capable of holding the contents of the largest tank. All tanks would be properly instrumented to prevent overfilling. The following precautions would be observed:

1. No unauthorized personnel would be allowed in the fenced-off tank farm area.
2. Only authorized personnel would be permitted to operate pumps, valves, and controls.
3. Unloading connections would be properly labeled and securely capped.
4. The tank farm area would be well lighted to assist in detection of spills and leakage.
5. Operating and maintenance personnel would be trained in the operation of oil drainage and collection equipment.
6. Vapor emission points would be visually checked periodically.

2.4.8 ENERGY REQUIREMENTS

Conventional beneficiation would require 12,100 kW during Phase I and 18,200 kW during Phase II.

2.4.9 ADDITIONAL PROCESS CONTROL MEASURES

The production areas of the washing facilities, feed preparation unit and flotation process would be paved, curbed and sloped to contain any spillage, clean-up water and rainwater. Collected water would be pumped back to its respective areas. During plant construction and operation, perimeter ditches would be used to collect runoff from the plant area. Roads in the plant area would be paved prior to construction to reduce particulate emissions.

2.5 WATER MANAGEMENT

Water management techniques at the South Fort Meade Mine would permit water to be recovered from ore transportation, washing, feed preparation, flotation processes and waste disposal, thus minimizing effluent discharges and consumptive uses. The proposed mine water system is presented in Figure 2-N. Estimated flow requirements for each water use are shown in Table 2-2, and a summary of the water balance, based on continuous operation 365 days per year, 24 hours per day, is presented in Table 2-3.

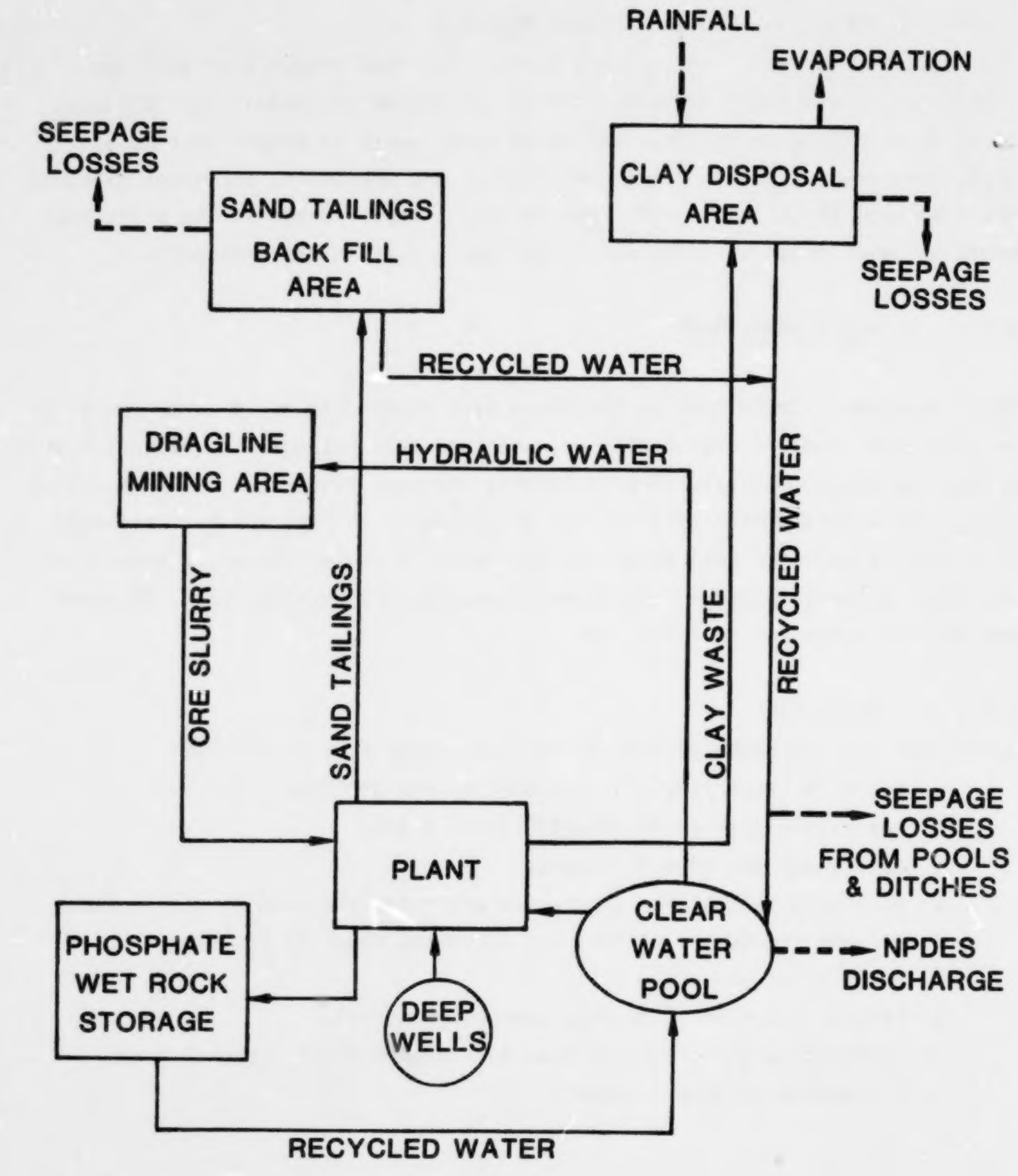
2.5.1 WATER USES

Water uses for the South Fort Meade Mine are identified as follows:

- Water for slurrying and transporting the ore from the mining area to the beneficiation plant.
- Seal water for transfer pumps.
- Washing/dilution/size separation water for the washing facilities.
- Diluent, transport medium, and scrubbing agent in the feed preparation process.
- Process water for flotation (non-consumptive).
- Transport waste clays and sand tailings to waste disposal areas.
- Miscellaneous potable water.

FIGURE 2-N

MINE WATER SYSTEM



SOURCE: MOBIL

Although most of the required water would be supplied by the recirculation system and retention of rainfall, the flotation plant's high quality water requirements would be satisfied directly from deep wells.

2.5.2 WATER SOURCES

The three sources of water for the mining operation would be ore water, rainfall and deep wells. Ore water would generally be unavailable for process purposes since it would be entrained in matrix clays. Rainfall varies seasonally and is approximately equivalent to evaporation; it is, therefore, not a consistent source of supply. The most reliable water supply is the deep aquifer system tapped by wells which would provide high quality makeup water on a continuous basis.

Mobil proposes to withdraw 15.7 mgd for flotation process and makeup water from the Lower Floridan Aquifer utilizing three wells to a depth of approximately 1,000 feet. Groundwater would also be withdrawn for pump seal water (0.691 mgd) and potable water (0.022 mgd) from the Upper Floridan Aquifer at an overall rate of 0.713 mgd using wells approximately 240 feet deep. The withdrawal points for the Upper Floridan Aquifer water source would change during the life of the mine. The proposed withdrawal of 16.413 mgd of groundwater was approved by the Southwest Florida Water Management District (SWFWMD), and Consumptive Use Permit (CUP) No. 205043 was issued to Mobil on October 7, 1980.

2.5.3 WATER LOSSES

During the mining and processing of phosphate, water could be lost from the system in several ways. The largest single loss would be water trapped in the waste clays. Additional water could be lost as seepage from clay settling areas and from sand tailings disposal areas. Evaporation would account for water losses which are considered equivalent to annual rainfall. A minor amount of water would be removed from the site in the phosphate product.

Seepage losses would account for about 16.5 percent of the water losses. Water would be recycled through the mine water recirculation system by a system of return-water ditches. At full development, about eight miles of ditches would be in service at all times. When the water level in the ditches exceeds the water table, water would seep into the aquifer. The magnitude of the seepage loss would depend on the depth and length of the ditches, the porosity of the soil, and the depth of the water table which fluctuates seasonally. Seepage into mine pits and ditches would add water to the system when the water table was above the water level in the pits and ditches. Considering pit seepage water as an input, the net seepage loss is estimated to be approximately 2.7 mgd. The majority of this water loss would enter the water table. However, some water would evaporate from the ditches, and approximately 5 percent of the total seepage loss would be commonly considered consumptive.

Production shipment moisture would account for the remainder of the water losses, with 2.0 percent of the total. Prior to shipment, the moisture level of the wet rock product is reduced to 13 percent. The remaining water is retained in the product as interstitial moisture and can be removed only by evaporation in the rock drying process. Water lost during product shipment is consumptive.

2.5.4 WATER MANAGEMENT

The South Fort Meade Mine would balance rainfall, evaporation and discharges to reduce groundwater consumption, allowing most of the water utilized in Mobil's operation to be recirculated water. Storage would be provided to accumulate rainfall and minimize discharges during heavy rainfall periods. However, some losses would be unavoidable and makeup water would be supplied from groundwater sources.

During the mine start-up period, water from the recirculation system would not meet demand because of the limited supplies available from the waste disposal areas. SWFWMD has authorized a maximum withdrawal of 16.413 mgd for up to 18 months before mine start up to develop an adequate reserve of recycleable water. The system would be balanced as the mine is placed in operation. Water management would be practiced throughout the proposed mine beginning when the ore is slurried for transport and culminating in the recovery of water from the disposal areas. As the mine develops and the reserve is depleted, adequate water would become available within the recirculation system (Table 2-3).

Internal recycling steps would be incorporated into the feed preparation facilities to minimize water use requirements. The feed preparation facilities would include a 500-foot diameter clarifier for consolidating the secondary clay wastes and returning clarified water directly to the plant. This immediate return of water minimizes seepage and evaporation losses that would otherwise occur in the mine water recirculation system. Smaller clarifiers would recover feed and remove plus 200-mesh material from the in-plant recycle water. These recycling steps would permit Mobil to use recycle water where deep well water is ordinarily required.

Mobil's water conservation plan includes the following measures:

- Recycled water from the mine water system would be utilized to the fullest possible extent for mining and beneficiation (approximately 90 percent).
- Discharges from the mine water recirculation system would be limited to periods when rainfall accumulation exceeded the system's storage capacity.
- Sufficient catchment area would be included in the mine water recirculation system to offset evaporation losses.
- The beneficiation plant itself would include recycling systems to make maximum use of internal plant water.
- Parallel trains of equipment in the beneficiation plant would ensure that the units do not run significantly under capacity and result in inefficient use of plant water.
- The beneficiation plant would recover very fine phosphate particles which would maximize recovery of the phosphate resource and result in more product recovery for the same volume of water used.
- A clarifier installed at the beneficiation plant would reduce the volume of water pumped to disposal areas with the clays and reduce the opportunities for water losses.

- Water system management would be an integral part of mine operations. Specific personnel would be assigned the various components of the recirculation system, checking equipment capacity, monitoring overall water use, and performing the various other routine tasks necessary for efficient operation of the system.

2.5.5 WATER DISCHARGE

The primary discharge from the mining area would occur from the 45-acre clear water pool adjacent to the processing facility. Under the proposed plant siting, the clear water discharge would flow into the Peace River by way of a vegetated drainage swale (outfall ditch) constructed parallel to the railroad route. The mine would have an intermittent discharge from the clear water pool primarily between the months of May and October when rainfall accumulation and runoff exceed the storage capacity of the system. The discharged volume would be directly dependent on local rainfall trends and the size of the drainage area included in the mine water recirculation system; it is expected to be greatest between June and September, a period when tropical storms are frequent in Florida. During the wet season the normal and maximum discharge volumes would be 9 mgd and 20 mgd, respectively. These values were derived from precipitation and evaporation rates for the area, the maximum area disturbed during mining, and the maximum quantity of surface water which can be utilized for processing.

EPA effluent guidelines for the phosphate mining industry (40 CFR 436.182) include pH and total suspended solids (TSS). The effluent guidelines mean and maximum discharge values are shown in the following chart.

Parameter	Mean	Maximum
TSS	30 mg/l	60 mg/l
pH	range (6 - 9)	

All discharges would be analyzed routinely for these two parameters to check discharge water quality.

There would be additional outfalls associated with the spillways of individual settling basins, but these would only discharge in extreme circumstances when excessive rainfall threatens to overtop the basins. These settling basin discharges would occur during the period between construction of the settling basin and reclamation of the basin. Over the active mining period, the location of the emergency discharge outfalls would shift as basins are reclaimed. Special precautionary measures, such as draining storage basins of excess water, would be implemented in the event of hurricane warnings in the area. All discharges would be monitored to ensure that discharge water quality meets all applicable standards.

Evaporation losses are offset by rainfall. Based on available statistics for the previous 15 years, evaporation from a given free water surface is approximately 10 inches per year greater than rainfall. This deficit is made up in the mine water recirculation system by accumulating rainfall runoff from active mining areas, inactive waste disposal areas consolidating prior to reclamation, and active reclamation areas. Seasonal rainfall accumulations exceed the storage capacity of the system and must be discharged. In the proposed mine water balance, evaporation losses plus discharge are assumed equal to rainfall accumulations within the mine water recirculation system. The other water losses must be made up from other sources that are discussed in detail in the following paragraphs. Average daily losses are reported in the following chart in terms of both total loss and consumptive loss.

Type of Loss	Total Loss (mgd)	Non-Consumptive Loss (mgd)	Consumptive Loss (mgd)	Consumptive Loss (%)
Clay Adsorption	11.642	1.746	9.896	85
Sand Tailings Moisture	1.725	1.725	--	0
Seepage	2.713	2.577	0.136	5
Product Shipment	0.333	--	0.333	100
Total	16.413	6.048	10.365	63.2

Clay adsorption accounts for approximately 71 percent of the total losses. During processing, the clays are suspended in water at about 3 to 5 percent solids. While in this dilute aqueous suspension, the clay particles adsorb large amounts of water. Clays dewater slowly after disposal. The proposed water balance assumes water is recovered as the clays consolidate to 18 percent solids. This recovery efficiency is considered good practice for operating mines. The clays continue to consolidate beyond 18 percent solids, but most dewatering beyond this point is lost to evapotranspiration.

As indicated in the above chart, 85 percent of the water lost to clay absorption is considered consumptive. The remaining 15 percent of the water is temporarily held in the clays and eventually seeps into the water table. Sand tailings moisture accounts for 10.5 percent of the total water loss to the system. Sand tailings are also pumped to waste disposal areas in aqueous suspension. The sand dewaters more rapidly and releases most of the water used in transportation. About 30 percent of the moisture is retained and eventually lost through seepage into the water table. Since virtually all of this water is returned to the water table, this water loss is nonconsumptive.

2.6 WASTE DISPOSAL

Mobil proposes to use conventional methods for disposal of waste sand tailings and clay. The sand tailings would principally be used to backfill mined areas (5,034 acres) and as fill in the construction of dikes for clay impoundment areas. Waste clays would be contained behind earthen dams constructed on natural ground (1,320 acres), or constructed in mined areas (8,363 acres). Average dike heights would be 38.7 feet above grade. The estimated power consumption for pumping waste sand and clay would be 1,004 x 10^6 kWh over the life of the mine.

The design, construction, inspection and maintenance of all impoundment dams at the South Fort Meade Mine would comply with the provisions of Chapter 17-9 of the Florida Administrative Code and with all other local, state, or Federal regulations governing the construction, maintenance and operation of dikes. The dams would be designed by a professional engineer registered in Florida. Field supervisors would complete daily inspections of active dikes. Full-time dam tenders would be employed as necessary for continuous inspection and minor repair work. Proper access and toe roads would be constructed and maintained to facilitate adequate dike inspections. Grass on the dikes would be maintained to prevent erosion and mowed to ensure visibility for inspection. Constant supervision of safe freeboard levels would be a regular function of plant management. A semi-annual inspection would be conducted on all dikes by a qualified soil engineering consultant. All findings would be reported in compliance with Chapter 17-9, Florida Administrative Code.

2.6.1 WASTE CLAY DISPOSAL

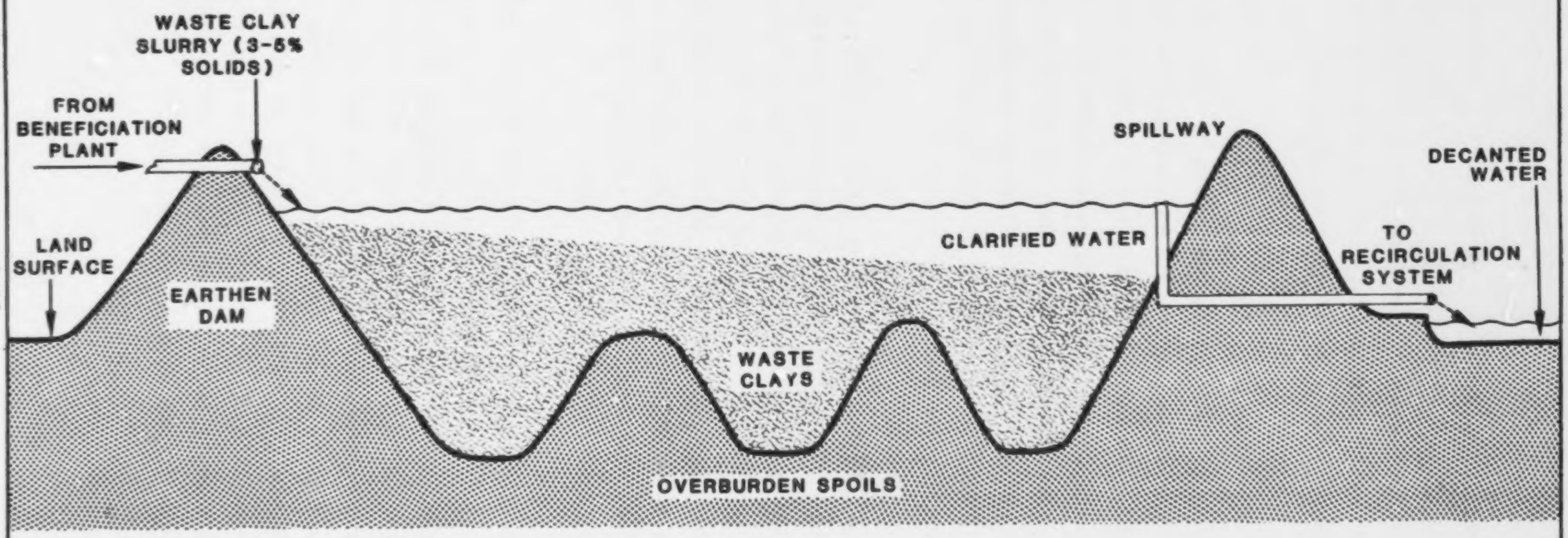
Substantial quantities of water (11.6 mgd) would be contained in the waste clays, increasing their volume and requiring considerable storage area. The conventional disposal plan would discharge waste clays at five percent solids behind earthen dams for consolidation and water decanting. Two to four years after the basin is taken out of service, the clay particles would consolidate to about 20 percent solids. During waste disposal operations clarified water would be drawn off through the spillways by gravity and would be recirculated into the plant system (Figure 2-O).

Figure 2-P shows the locations of the clay settling areas proposed for the South Fort Meade Mine. A total of 9,683 acres would be devoted to storing approximately 328,000 acre-feet of waste clays at 20 percent solids. The initial waste clay settling areas, CS-1 and CS-2, would be constructed on unmined ground with dikes constructed of overburden material. These settling areas would be able to hold the waste clays generated during the first five years of mining. After construction of CS-1 and CS-2, all other waste disposal areas would be constructed on mined land.

All the clay wastes generated during the life of the mine would be contained in Areas CS-1 through CS-14. However, a portion of the clay wastes allocated to Area CS-14 would be transferred to CS-15 to provide below-grade fill for the last mining area on the site. This low level fill would provide a shallow aquatic environment for eventual reclamation as a wetland. No dam is planned for CS-15 since the fill level would be approximately three feet below natural grade. A portion of the clay fill for CS-15 would be obtained by pumping clays out of CS-14 until the clay level in CS-14 averages three feet below existing grade. This would leave both Areas CS-14 and CS-15 approximately three feet below grade for reclamation as wetlands.

FIGURE 2-0

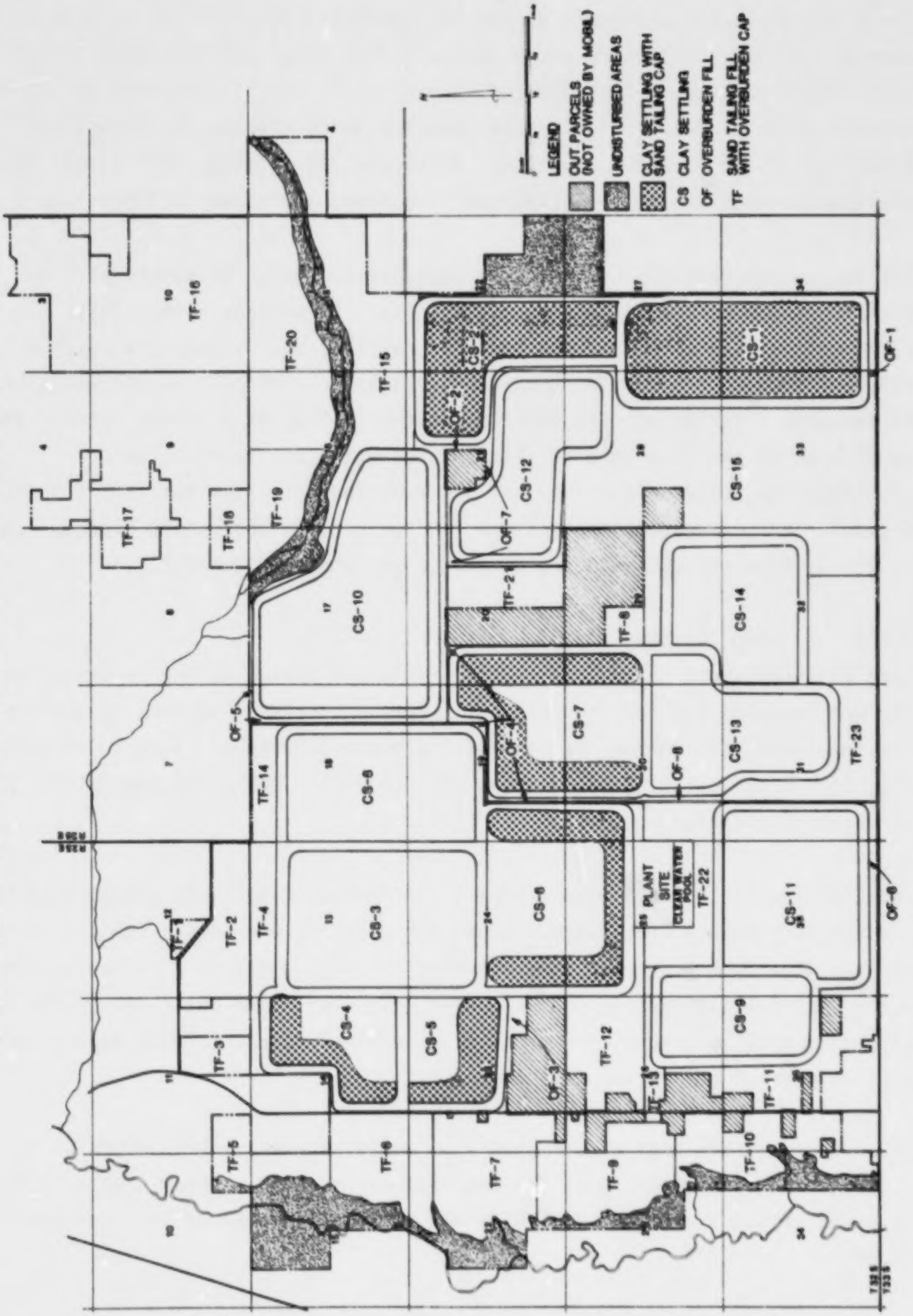
WASTE CLAY SETTLING METHOD



SOURCE: MOBIL

NOTE: NOT TO SCALE

CONVENTIONAL WASTE DISPOSAL PLAN



SOURCE: MOBIL

After the areas are allowed a period of consolidation, sand tailings would be used to cap the interior of Areas CS-1 and CS-2 to an average depth of two feet, and a portion of the interior of Areas CS-4, CS-5, CS-6 and CS-7 to an average depth of 8 to 10 feet. The sand cap would enhance the structural stability of the reclaimed surface. Acreages, dam heights, fill levels and reclaimed elevations for all clay settling areas are shown in Table 2-4.

A flow through settling technique is commonly used with conventional clay settling and would be implemented at the South Fort Meade mine. This technique is generally utilized for clay settling basins that are located adjacent to each other. The procedure consists of introducing the waste clay stream into a series of clay settling basins instead of a single basin. The advantages of the flow through settling technique are improved water clarification, clay compaction, and water management. The specific filling schedule and active settling acreage for the conventional waste disposal case using the flow through settling technique are shown in Table 2-5.

2.6.2 SAND TAILINGS DISPOSAL

Sand tailings would be used as backfill in mined areas, in the construction of earthen dams and for capping material. Approximately 76 percent of the sand tailings generated during the life of the mine would be utilized in 23 tailings fill areas totaling 5,034 acres (Figure 2-P). Table 2-6 summarizes the acreages of these areas.

Sand tailings fill areas would receive slurried sand tailings pumped from the processing plant filling voids between the piles of overburden stacked during mining. The decanted water from the sand tailings would be directed to the water recirculation system. Overburden extending above the level of the sand tailings would be graded, bringing the mined land to approximate natural grade with an average overburden cap of two feet.

About five million tons of sand tailings would be used as fill material in the construction of earthern dams for the disposal of clay wastes. Approximately 32.5 million tons of sand tailings would be used as a cap on the clay settling areas.

2.6.3 OVERBURDEN

Overburden would be used to backfill mined lands, for construction of waste clay storage areas and for capping sand tailings fill areas. Eight overburden fill areas totaling 308 acres are included in the waste disposal plan (Figure 2-P).

2.7 RECLAMATION

During the course of mining, Mobil would disturb and reclaim 15,194 acres of the South Fort Meade Mine site. Of the 2,055 acres of wetlands on the site, 1,923 acres, would be disturbed by mining. When reclamation is complete, the total wetland acreage would be approximately 93 percent of that existing on the site; the combined forested stream channel and wetland acreage would exceed the existing wetland acreage by approximately seven percent. The reclaimed site is also scheduled to have approximately 1,940 acres planted as upland hardwood and mixed forest. Reclaimed upland mixed forest would serve to expand the forested zone along the Peace River and Bowlegs Creek and provide densely forested stands. The acreage distribution of the various land use categories is shown for both reclaimed and disturbed land in Table 2-7.

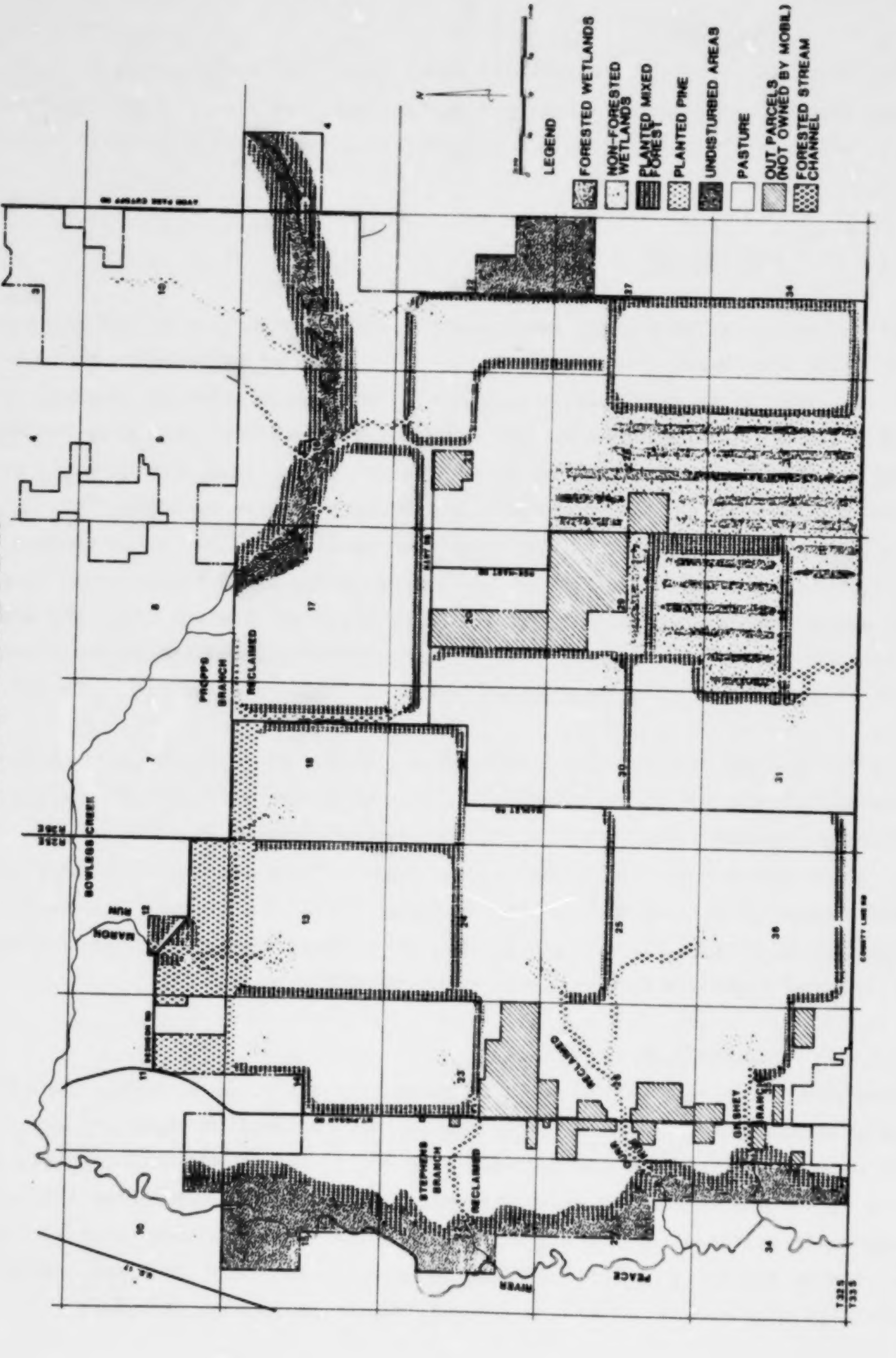
Figure 2-Q shows the reclaimed areas on the site. Agriculture would be the predominant use of the reclaimed site, with more than a 49 percent increase in improved pasture acreage. Planted pine acreage, presently occupying 340 acres, would be harvested before mining begins. Planted pine reforestation would cover 34 percent more of the reclaimed site. Agricultural uses would be feasible on most of the reclaimed site, and some acreage would have sufficient structural stability for residential and industrial uses.

2.7.1 RECLAMATION OF LANDFORMS

Landforms after reclamation would be suited for agricultural uses. Due to the subsidence which the above-grade uncapped clay reclamation areas are expected to undergo, these areas would probably be restricted to agricultural uses in the forseeable future. However, the sand tailings fill, overburden fill and the reclaimed plant site areas would have sufficient structural stability to allow residential or industrial development. In addition, the sand capped portions of the clay settling areas should have sufficient structural

FIGURE 2-Q

POST RECLAMATION LAND USE
CONVENTIONAL PLAN



SOURCE: MOBIL

bility to permit construction of small buildings. The following summary shows the acreage totals for the proposed reclaimed landforms.

Reclaimed Landform	Reclaimed Acreage
Sand tailings fill areas with overburden cap	5,034*
Above-grade clay settling areas (uncapped)	6,681
Above-grade clay settling areas with sand cap	1,489
Below-grade clay settling areas	1,513
Overburden fill areas	308*
Miscellaneous backfill areas (clear water pond)	45
Disturbed natural ground (plant site and entrance railroad)	124
Total	15,194

* Includes setbacks from public roads and property boundaries which would be disturbed but not mined.

2.7.1.1 Sand Tailings Fill Areas

The 5,034 acres of sand tailings fill areas would be capped with overburden to an average depth of two feet in order to provide a reclaimed soil with favorable agronomic properties. The majority of the sand tailings fill areas would be initially reclaimed to improved pasture. Sand tailings fill areas TF-2 and TF-3 (Figure 2-P) are scheduled for pine plantings and would be the first large upland reclamation areas on the site.

2.7.1.2 Above-Grade Clay Fill Areas

The 6,681 acres of uncapped above-grade clay fill areas would have phosphatic clay both as the backfill material and the reclaimed surface soil. Soils such as these are best suited to perennial forage crops; therefore, improved pasture would be established on most of the above-grade clay fill areas. The development of improved pasture would control erosion and stabilize the reclaimed soils.

2.7.1.3 Above-Grade Clay Fill Areas Capped with Sand

The 1,489 acres of clay settling areas capped with sand would have sand tailings as the surface soil and clay as the subsurface fill. The thickness of the proposed sand cap would range from 8 to 10 feet. Some of the sand capped clay settling areas would be used as improved pasture as has been done in the past. Other areas would be reforested with a mixture of native tree species.

2.7.1.4 Overburden Fill Areas

The eight overburden fill areas (308 acres) would have overburden as both the backfill and surface soil material. These areas would be reclaimed to approximately natural grade and would have good structural stability and drainage properties. Since overburden soils have good structural stability properties, nutrient retention capacity and moisture holding capacity, the reclaimed overburden areas would constitute multipurpose land suitable for a variety of structural and agricultural uses similar to those of the present site.

2.7.1.5 Disturbed Natural Ground and Miscellaneous Backfill Areas

The reclaimed plant site area would include both natural ground and the clear water pool backfilled with overburden. As such, the area would have sufficient load bearing strength to permit unrestricted post-reclamation development. The natural and overburden surface soils would be capable of supporting agricultural uses such as improved pasture and silviculture. The initial plan is to reclaim this area as improved pasture.

2.7.2 RECLAMATION OF STREAM CHANNELS AND WETLANDS

The proposed plan provides for the reclamation of approximately 60,000 linear feet of stream channels and 1,780 acres of wetlands on the site. The reclaimed stream channels would replace the minor tributaries of the Peace River and Bowlegs Creek which would be disturbed by mining. Two types of wetlands included in the reclamation plan are below-grade clay fill areas, and shallow depressions near the confluence of restored stream channels with natural drainage courses.

2.7.2.1 Stream Channel Reclamation

Included in the stream reclamation plans are the disturbed portions of Gilshey Branch, Gurr Run, Stephens Branch, Maron Run, Propps Branch and several unnamed tributaries to Bowlegs Creek. In addition, a stream channel would be reclaimed to drain the south central portion of the site south to Parker Branch. The design of reclaimed stream channels would be based on the size of their reclaimed drainage basins. The floodplain of each channel would be designed to accommodate a 25-year, 24-hour rainfall event. All drainage from upland reclamation areas would pass through a reclaimed marsh before entering the natural drainage courses.

All stream channel reclamation would be done in sand tailings fill or overburden fill areas. Stream channel reclamation plans provide for the creation of a normal water level channel and an associated floodplain. A gradall or small dragline would be used to excavate a channel in a meandering fashion through the reclamation areas. The floodplain for the reclaimed stream would be provided by grading the bank slopes to gentle gradients. In the sand tailings fill areas, the excavation and rough grading would be done in the sand fill prior to the deposition of the overburden cap. Final grading and sloping of the floodplain would be done during placement of the overburden cap.

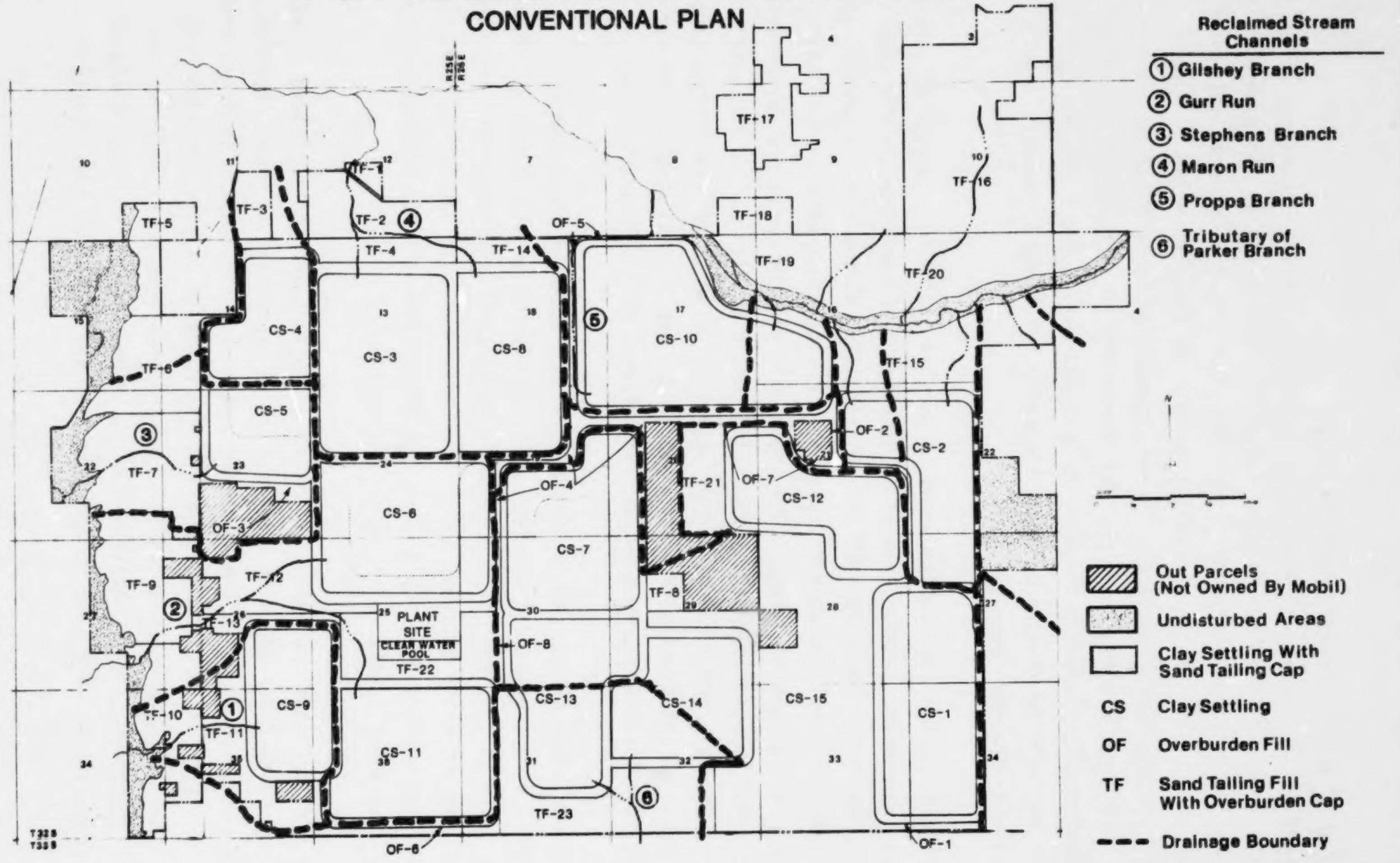
In all reclaimed stream channels, shallow pools would be excavated at intervals of approximately 500 feet along the length of the channels. These pools would be designed to have a bottom depth three feet below the reclaimed stream bed and would be about 100 feet in diameter. The inclusion of shallow pools along the channels would provide a deep, permanent water component to serve as a water supply for wildlife and cattle.

Tentative locations and approximate drainage basins for the reclaimed stream channels planned for the site are shown in Figure 2-R. The exact location of the reclaimed stream channels would depend primarily on the internal drainage pattern in each reclaimed area. Although not in exactly the same location, the reclaimed channels would be in the same general vicinity as the existing streams. Where possible, the reclaimed streams would be designed to have approximately the same lengths and drainage basins as those existing.

FIGURE 2-R

PROPOSED LOCATIONS AND APPROXIMATE DRAINAGE BASINS FOR RECLAIMED STREAM CHANNELS

CONVENTIONAL PLAN



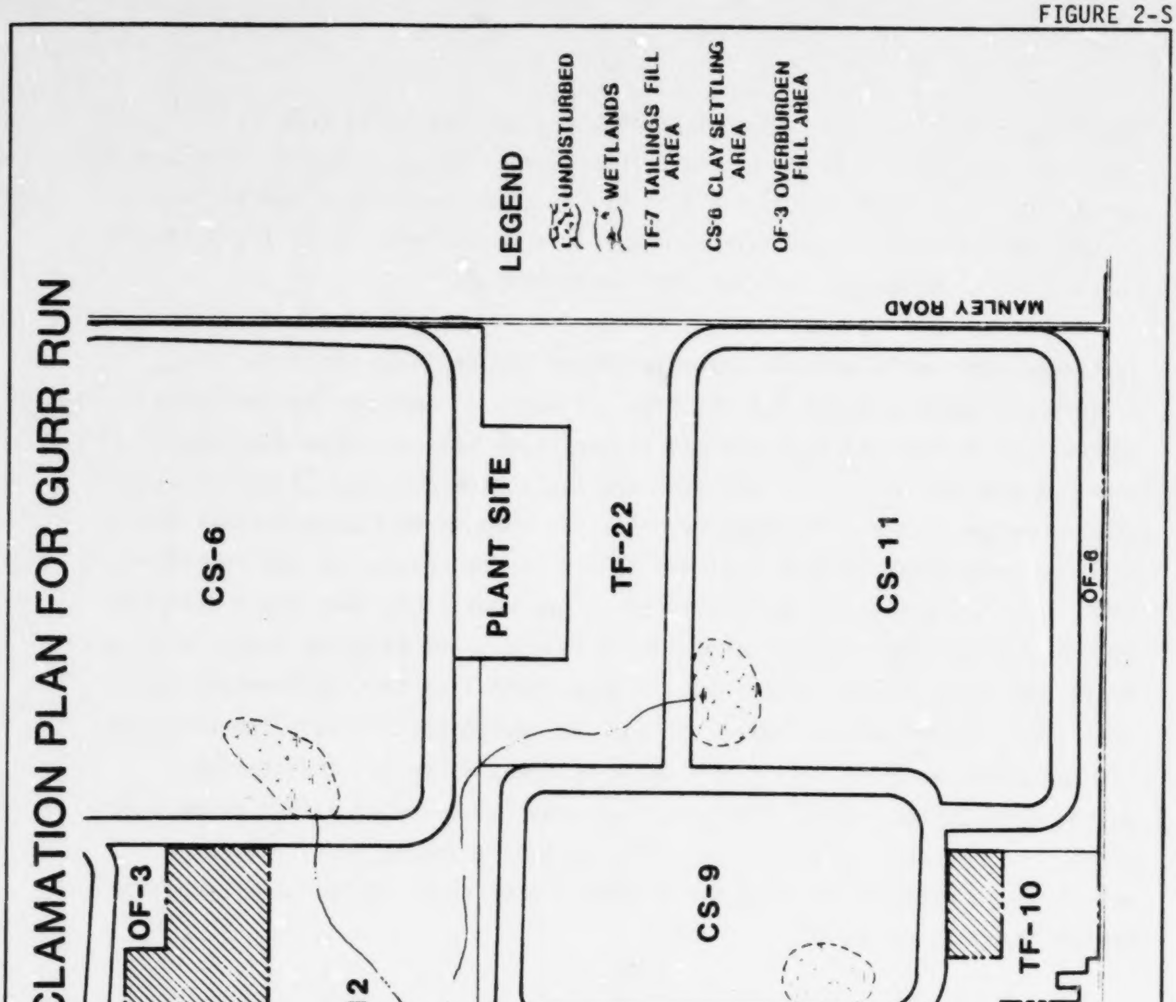
SOURCE: MOBIL

Reclaimed elevations have been planned to provide gradients towards the major undisturbed drainage courses on the site. When reclamation is complete, the western and southwestern portions of the site would drain to the Peace River, the northern and northeastern portions to Bowlegs Creek, and the south central and southeastern portions to Parker Branch.

Reclaimed land would provide the majority of the drainage basin for the reclaimed streams planned for the site. Figure 2-S depicts the conceptual reclamation scheme for Gurr Run and its drainage basin. Areas CS-6 and CS-11 serve as the headwaters for the northern and southern prongs of the reclaimed stream, respectively. Drainage water passes through reclaimed marshes before exiting these areas through drainage swales in the remnant of the retaining dams. The two prongs of the reclaimed stream would intersect these drainage swales, collect the drainage from the reclaimed plant site and Areas TF-22 and TF-12, and then intersect to form a single channel in the southwestern corner of TF-12. The reclaimed channel of Gurr Run would then collect the drainage from portions of TF-9, TF-10, and TF-13 before joining its undisturbed downstream segment. Since tailings fill areas would be reclaimed to natural grade, the reclaimed channel would also collect drainage from adjacent out-parcels. Similar reclamation schemes are planned for the other reclaimed stream channels on the site.

As annual mining plans are filed for each mining unit, Mobil would submit detailed plans (for mining, diverting the flow when necessary, and reclaiming stream channels within the mining unit) to the State of Florida. In some cases, no diversion would be necessary because the minor tributaries mined are not flow-through systems. For example, in the case of Stephens Branch, the tributaries of Bowlegs Creek, and the tributary to Parker Branch, the upstream portions of their respective drainage basins would be mined first, followed by mining of their downstream segments. In other cases, such as that of Gurr Run and Gilshey Branch, the mine plan calls for the downstream portions of the channels to be mined first, followed by mining of the upstream portions in subsequent years. This necessitates diversion of the flow in these streams (which occurs primarily during the rainy season) to the mine water recirculation system prior to mining of the downstream portions.

FIGURE 2-S



CONCEPTUAL RECLAMATION PLAN FOR GURR RUN

SOURCE: ZELLARS-WILLIAMS

2.7.2.2 Below-Grade Clay Filled Areas

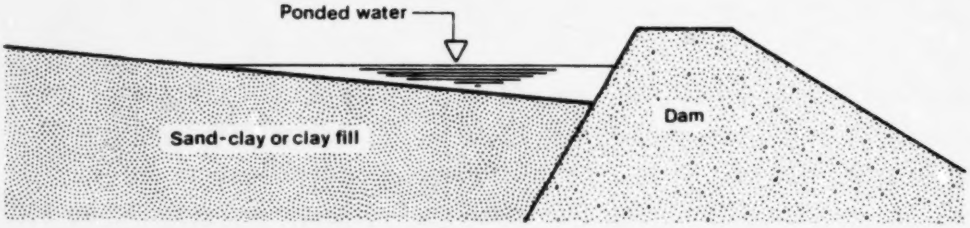
Below-grade clay filled areas (1,513 acres) would be designed specifically for wetland reclamation. The reclaimed wetlands proposed for these areas would have similar functions as the existing wetlands on the site. All reclaimed wetlands would be positioned on the site to receive drainage from upland reclamation areas. Drainage outfalls and fill levels would be designed to provide areas of open water adjoined by seasonally flooded zones gradually sloping up to the graded spoil areas which would be inundated only at high water.

When reclamation is complete, Area CS-14 would receive a portion of the drainage from CS-13 (Figure 2-P). Area CS-15 would receive drainage from CS-1, CS-7, CS-12, TF-8 and TF-21. The below-grade nature of these areas, the clay base, and the drainage inputs from the other reclamation areas should be sufficient to maintain a wetland environment.

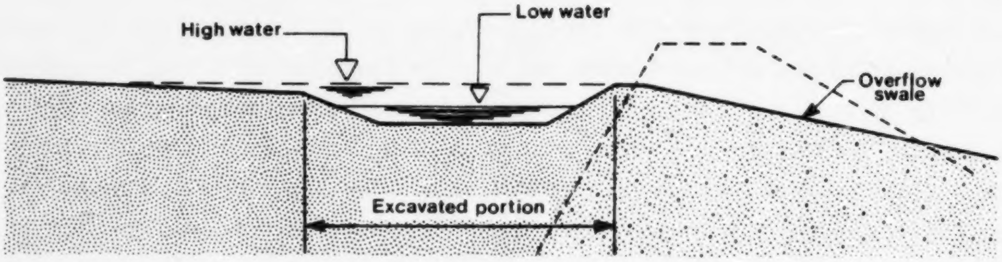
2.7.2.3 Shallow Depressions

Thirteen shallow depressions would be constructed on 345 acres of marsh where drainage exits reclaimed waste disposal areas. These depressions are desirable for use as reclaimed wetlands, and the dams would be graded away from the areas to leave the depressions intact. The size of the ponded area would be controlled by the design elevation of the overflow drainage swale. The elevation of the overflow swale would be designed so that at high water, the ponded area would cover an area equivalent to three percent of the acreage represented in the drainage basin for the reclaimed wetland. In the immediate vicinity of the overflow swale, a gradall or small dragline would be used to deepen the depression to a minimum depth of four feet below the elevation of the swale. This excavation is intended to provide a permanent standing water component in the reclaimed wetland. The reclaimed wetland would consist of a small area of permanent water around the overflow drainage swale surrounded by a larger, gently sloping area that is seasonally flooded (Figure 2-T).

FORMATION OF SHALLOW DEPRESSIONS



During fill



During reclamation

SOURCE: MOBIL

NOTE: NOT TO SCALE

2.7.3 REVEGETATION

The conventional clay settling reclamation plan would provide for revegetation of all land disturbed by mining. The six basic revegetation programs in this plan are reforestation along reclaimed stream channels, wetland reforestation, nonforested wetland revegetation, upland mixed reforestation, commercial pine plantings, and improved pasture planting. Each of these programs is discussed in detail in the following subsections.

2.7.3.1 Reforestation Along Stream Channels

Reforestation of 277 acres would be accomplished along the reclaimed stream channels. Because of the limited experience with reforesting of stream channels, Mobil initiated a reforestation feasibility study on Sink Branch near Fort Meade in the fall of 1979. A portion of Sink Branch had been disturbed by a phosphate mining operation in the 1950's. In the feasibility study, Mobil excavated a meandering channel (through an adjacent reclaimed area) for rerouting a section of the creek. The new channel was then divided into four segments for the following soil treatment:

- 1-foot layer of organic soil over overburden substrate
- 0.5-foot layer of organic soil over overburden substrate
- Overburden substrate plus fertilization as dictated by soil test
- Overburden substrate along, i.e., the control treatment.

A variety of native trees were transplanted along the channel. The three types of transplant stock used in the plantings were two-inch to four-inch trees obtained from nearby Mobil property, potted seedlings obtained from a commercial nursery, and bare-root seedlings obtained from the Division of Forestry.

The reclamation area is being monitored by Mobil to assess the impact of diversion on water quality and the effect of soil treatment and transplant type on tree survival. The initial results indicate the diversion had no impact on the stream's water quality. Overall tree survival rates are slightly higher in the plots that receive organic amendments, but the type of transplant stock appears more important to transplant survival than organic treatments. Tree-spade and potted transplants recorded the best survival rates in all treatments, but some bare-root transplants, notably sweetgum, have very good survival rates.

Mobil plans to continue monitoring the Sink Branch reclamation area to determine if the initial trends continue and if they are reflected in tree growth as well as survival. Mobil also plans to monitor closely the ongoing Division of Forestry research program on the reforestation of disturbed phosphate land. The results of these and other projects would likely point the way to improved reforestation techniques for reclaimed phosphate land.

Mobil proposes to reforest the reclaimed stream channels in a manner similar to that followed at Sink Branch. Figure 2-U depicts the proposed plantings along the stream channels. Hydric species such as cypress and black gum would be planted along the margins of the reclaimed channel. Transition species such as sweetgum, red maple, and laurel oak would be planted in the reclaimed floodplain of the streams. Mesic species such as slash pine and dogwood would be planted along the margins of the forested areas.

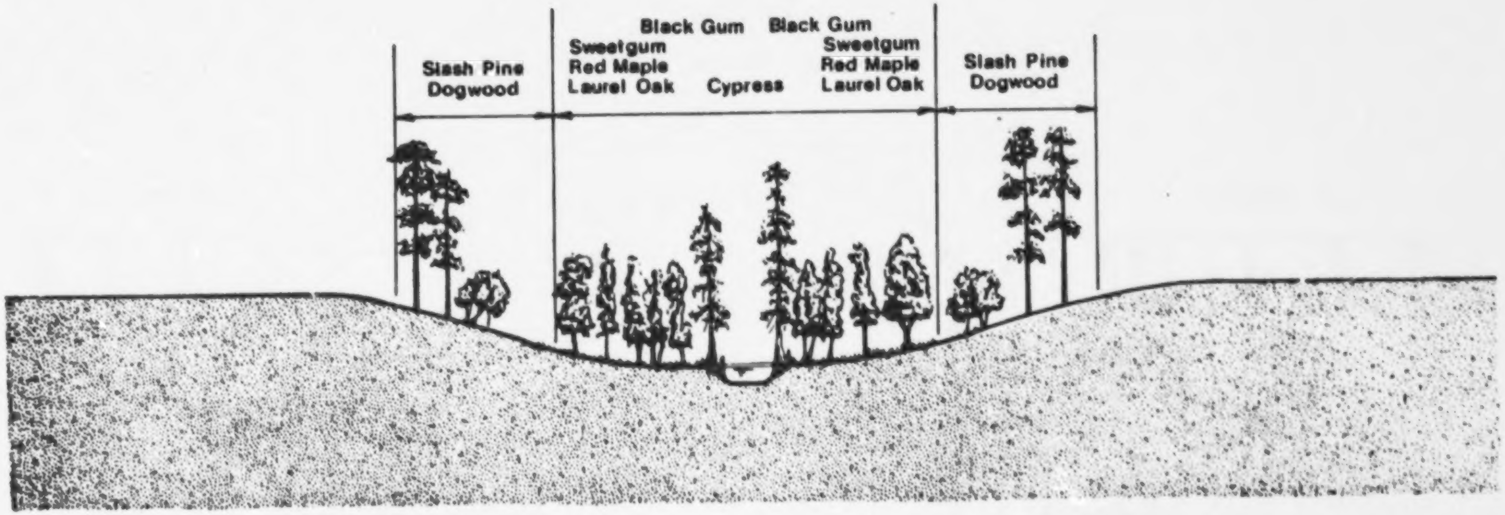
Potted seedlings would be used as the primary transplant stock in the reforestation effort. This stock has exhibited good survival rates and offers the greatest flexibility in terms of planting dates and availability. Potted transplant stock would be supplemented with tree-spade transplants when appropriate species are available in on-site areas that are to be mined, and with seedlings such as sweetgum that give acceptable survival rates when planted bare-root. Approximately 10 foot x 10 foot spacings are planned for the reforestation areas. This results in a planting density of more than 400 trees per acre. If the survival rate falls below 50 percent after one growing season, additional plantings would bring the density to a minimum of 200 trees per acre.

2.7.3.2 Wetland Reforestation

The proposed wetland revegetation program for below-grade clay fill Area CS-14 is graphically represented in Figure 2-V. The acres of graded spoil areas would be reforestated with a variety of native tree species. Wetland species such as bald cypress, blackgum, and water ash would be the dominate plantings.

FIGURE 2-U

REFORESTATION OF RECLAIMED STREAM CHANNELS

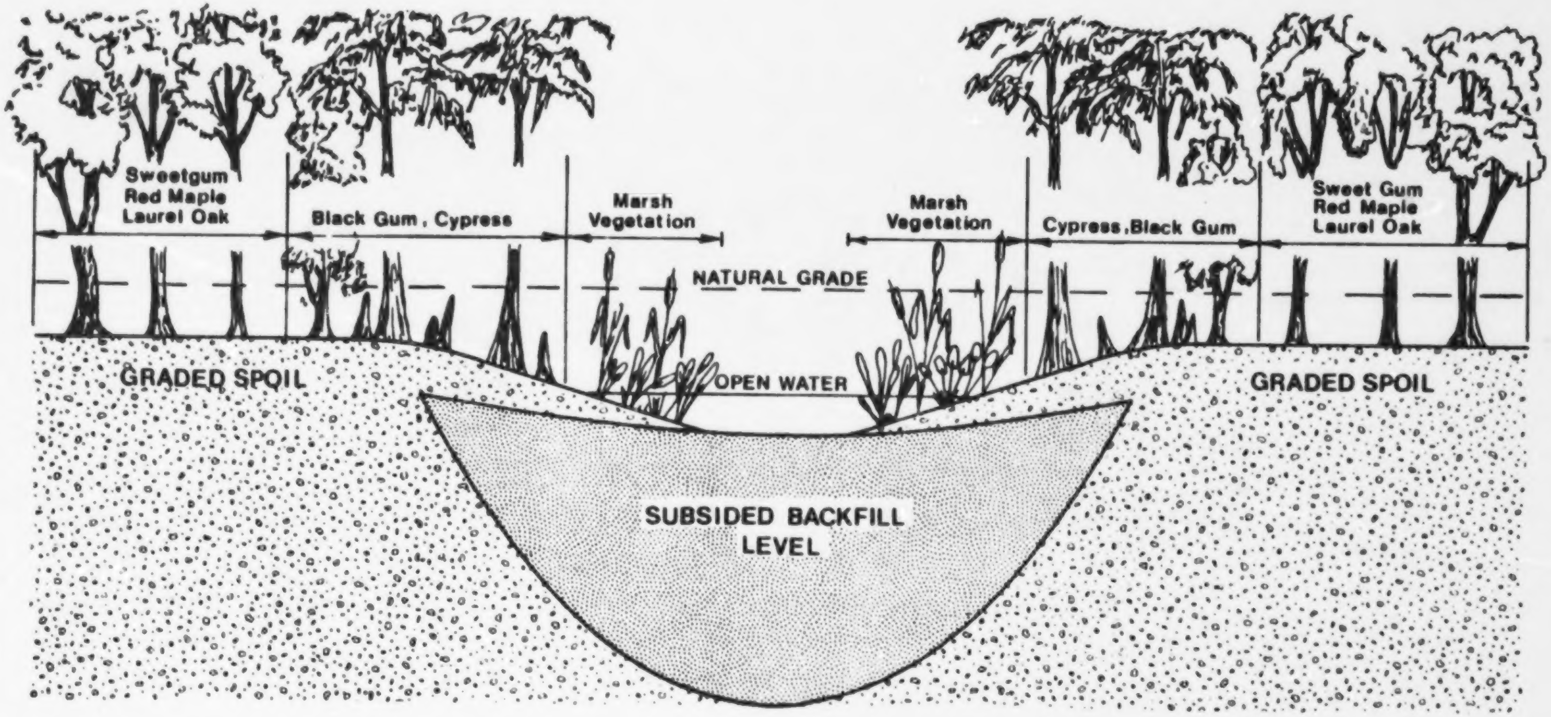


NOTE: NOT TO SCALE

SOURCE: MOBIL

FIGURE 2-V

REVEGETATION OF BELOW-GRADE CLAY RECLAMATION AREA



SOURCE: MOBIL

NOTE: NOT TO SCALE

A planting density of approximately 400 trees per acre is planned with both bare-root and potted seedlings as transplant stock. If necessary, the areas would be replanted to achieve a minimum stand density of 200 trees per acre.

2.7.3.3 Nonforested Wetlands

Approximately 957 acres of marsh would be reclaimed in the below-grade clay fill area CS-14. An additional 345 acres of marsh would be provided by the shallow depressions created in above-grade clay fill areas. All reclaimed marshes would be revegetated.

As with wetland reforestation, the revegetation of reclaimed marshes is currently receiving heavy research emphasis by the phosphate industry. Approaches to marsh revegetation include the use of substrates from existing marshes as a seed and vegetative propagule source, the transplanting of the desired vegetation from existing marshes, and simply allowing wetland environments to revegetate naturally. Each approach has been successful in certain areas. Research may suggest more effective alternative approaches. In view of the rapid developments in this field, Mobil believes that specifying detailed marsh revegetation plans for reclamation efforts that would take place more than 10 years in the future is inappropriate. Mobil is required by state law to provide a 50 percent herbaceous cover on all nonforested wetlands. When the reclamation plans for these areas are submitted to the state for approval, Mobil would propose specific marsh revegetation methods based on the best state-of-the-art technology available.

2.7.3.4 Upland Mixed Reforestation

The reclamation plan provides for reforestation of approximately 1,271 acres of upland land with a mixture of native tree species. These plantings are intended primarily to serve environmental reclamation goals. Two general types of plantings would be included in the upland reforestation areas. One consists of reforestation plantings adjacent to undisturbed forested areas. The reclamation plan would provide for the reforestation of approximately 500-foot wide strips on reclaimed land adjacent to the undisturbed forested areas along the Peace River and Bowlegs Creek. The plan also provides for a 41-acre reforestation block adjacent to the forested area along the undisturbed lower portions of Maron Run. The undisturbed forested areas are among the most environmentally valuable areas on the site. The intent of the reforestation plantings is to expand this forested zone, and enhance the aesthetic value and wildlife habitat potential of both the undisturbed and reclaimed forests.

The second type of upland mixed reforestation would be the planting of elongated strands approximately 200 feet wide in reclamation areas. These strands would provide reclaimed areas with densely forested strips that serve as cover and feeding grounds for wildlife, corridors for wildlife movement, aesthetic breaks in the landscape, and eventual shade areas for cattle. As such, the strands would be planted in a configuration that dissects reclamation areas whenever reclaimed soil conditions permit. Because of the questionable structural ability of clay soils to support mature tree growth, reforestation strands in reclaimed clay fill areas would be planted along the graded remnants of the waste disposal dams. Figure 2-Q depicts the conceptual scheme for the upland mined reforestation plantings.

A variety of native hardwood and coniferous trees would be included in the reforestation plantings. Species such as longleaf pine, live oak, and dogwood would be planted on the well-drained sites, while species such as water oak, laurel oak, sweetgum, and slash pine are planted on the wetter sites. All these species are available either as potted seedlings from commercial nurseries or bare-root seedlings from the Division of Forestry. Mobil currently plans to use potted seedlings as the primary transplant stock for the hardwood species and bare-root seedling as the transplant stock for pine species. When appropriate species are available nearby, tree-spade transplants would supplement the seedling transplant stock.

An average planting density of approximately 400 trees per acre is planned for the upland reforestation areas. This corresponds to an average spacing of about 10 feet by 10 feet, but not all reforestation plantings would be made at this regular spacing. At various intervals throughout the upland reforestation plantings, dense thickets would be planted to provide escape cover for wildlife and general diversity to the planting scheme. These thickets average about an acre in size and would be planted generally in a single species at a density of about 1,000 trees per acre. All reforestation areas would be replanted as necessary to achieve an average density of 200 trees per acre after one growing season. The reforestation areas would be protected from grazing for a period of five years. During this period, additional natural reforestation of these areas would probably occur. Black cherry and sugarberry, whose seeds are dispersed by birds, are likely volunteer species in the strands and blocks that do not adjoin undisturbed forests. In the reforestation zones adjacent to the undisturbed forested areas, a more diverse volunteer tree growth is expected because of the proximity of the natural seed source.

2.7.3.5 Pine Plantations

Approximately 453 acres of planted pine reforestation would be provided on the reclaimed site. These plantings serve economic goals for the reclaimed site, specifically to replace the economic value lost in the mining of 339 acres of existing pine plantations.

Pine plantings would be included in Areas TF-2 and TF-3. These areas are among the first large upland reclamation areas avalable on site. Pine plantings on overburden soils such as that of Area TF-2 have produced successsful results. Mobil plans to assess the silvicultural potential of its reclaimed land by utilizing these two areas as test plantings. If the pine plantings are successful in these areas, Mobil may amend its proposed revegetation plan to include more pine plantings in the latter stages of mine life.

The pine plantations would be established using standard commercial reforestation techniques. During the winter dormant season, bare-root slash pine seedlings would be transplanted at a spacing of approximately 8 feet by 8 feet, for an initial planting density of approximately 680 trees per acre.

2.7.3.6 Improved Pasture

The reclamation plan would provide for improved pasture as the initial vegetative cover for approximately 11,413 acres of reclaimed land. Improved pasture would be established on portions of all upland reclaimed landforms(clay settling areas and sand tailings fill areas with overburden cap) and would be the dominant vegetative cover on the reclaimed site.

The choice of improved pasture as the dominant revegetation method is based on several considerations. Control of erosion and stabilization of reclaimed soils is an absolute must for the revegetation program. Forage crops are the best known method of rapidly establishing a vegetative cover. The tillage properties of reclaimed clay soils are generally poor, due initially to the absence of soil organic matter. Improved pastures require tillage only during the establishment phase, which can be timed to coincide with dry periods when tillage is less difficult. Moreover, the establishment of pasture sods, particularly those which include legumes, is an excellent means of encouraging the development of soil organic matter, which improves the tillage properties of the soils. Livestock production is one of Central Florida's agricultural bases, and reclaimed grazing land is in great demand among local cattlemen. Forage crops adapted to all reclaimed soil types can be selected. Properly managed reclaimed pastures have the potential of producing large quantities of high quality forage with minimal inputs. Finally, improved pasture is much easier to convert to alternative uses because clearing costs are minimal compared to clearing of woodlands. All of these considerations combine to make improved pasture the optimum choice for the majority of reclaimed land.

All improved pasture plantings would include both a grass and a legume component. Legumes, in combination with their bacterial symbiont, have the capacity to fix atmospheric nitrogen for utilization by higher plants. Therefore, the legume component would serve both as a forage complement to the grass and as a source of nitrogen to the sod. An effort would be made to select the best forage species for the particular landform and reclaimed surface soil type. As with nearly all phases of phosphate land reclamation, ongoing research is continually identifying new forage varieties that have promise. The selection of the particular grass and legume species used in revegetation would be made at the time reclamation programs are filed for the particular areas. Pensacola bahiagrass is a reliable and versatile grass for use on sand, clay, and overburden soils. This grass tolerates short-term water logged soil conditions and produces good yields of acceptable quality forage under a wide range of management practices. Unless more promising species become available, Pensacola bahiagrass would be the principal grass used in the revegetation program.

Legumes would be either interseeded with the grass or overseeded over established grass sods. The cool season legume, white clover, produces high yields of excellent quality forage on phosphatic clay soils. Warm season legumes such as hairy indigo and aeschynomene do well on both overburden and clay soils. All legume seed would be inoculated with the proper bacterial inoculant to ensure the capacity to fix atmospheric nitrogen.

Prior to all forage plantings, fertilizer and lime would be applied according to soil test results. The need for lime is unlikely on most reclaimed soils in view of the high pH and calcium and magnesium levels reported for the reclaimed soil materials. All improved pasture areas would be protected from grazing until the forage plantings are firmly established.

2.7.4 ANNUAL RECLAMATION SCHEDULE

Table 2-8 summarizes the proposed annual reclamation schedule for the South Fort Meade Mine. In preparing this shedule, a total of three years after final fill is allotted to complete reclamation of sand tailings and overburden fills. Of this total, two years would be utilized in grading the areas to approved slopes, establishing drainage and planting vegetative cover. The third year is allotted for the vegetative cover to become established.

After final fill, seven years have been allotted to complete reclamation of uncapped clay settling areas. Of this total, three years are projected to be required for the areas to consolidate to 20 percent solids; three years to grade, establish drainage and plant a vegetative cover; and one additional year to allow the vegetative cover to become established.

Two years have been allotted after placement of the sand cap to complete reclamation of capped clay settling areas. One year is required to grade the fill and retaining dams to approved slopes and to plant the vegetative cover; the remaining year is required for the vegetative cover to become established. Because the mined areas would be used for waste disposal, reclamation lags several years behind the mining schedule. Reclamation activities initially proceed at a slower rate than mining activities; however, reclamation proceeds rapidly for the last one-third of mine life and out-paces the rate of disturbance.

2.8 ECONOMIC CONSIDERATIONS

Mobil's economic investment in the South Fort Meade Mine is expected to total 240 million dollars. The development of the mine would be in two progressively planned phases: Phase I is scheduled to start up in 1984 following a 21-month construction period. Phase I operations, with an estimated capacity of 1.7 million tons per year, would include one dragline, an associated beneficiation plant, the initial clay settling areas and auxilliary facilities. The start up of Phase II is planned for 1987 following a similar 21-month construction interval. Facilities comparable to Phase I would be developed in Phase II, increasing ultimate production capacity to 3.4 million tons per year. The construction costs for each phase of development are planned at 120 million dollars, respectively. The relative percentages of construction expenditures are given as follows.

	Amount	Obtain Within Region
Labor	29%	95%
Materials	29%	50%
Subcontract	25%	80%
Overhead	17%	80%
Total	100%	75%

Mobil would hire and encourage its contractors to utilize the local work force to the extent possible. Approximately 95 percent of the construction labor is planned to come from the existing labor pool in the area of the proposed mine. An average of 400 workers would be needed for the construction of the mine. Construction would be scheduled on an 8-hour day, 5 days per week.

Phase I operations would require 147 full-time employees, increasing to 233 employees for Phase II operations. The primary source of operating personnel would be employees transferred from Mobil's existing mines. Payroll expenditures of 3.3 million dollars annually for 147 permanent operating employees would occur during the start-up production between 1984 and 1987. This expenditure would rise to 5.1 million dollars annually as the permanent work force expands to 233 employees upon the completion of construction in 1987.

TABLE 2-1

FLOTATION REAGENTS

Reagent	Dosage (gal/day)	Dilution	Storage Volume (gal)
#5 Fuel Oil	4,230	13,200:1	60,000
Caustic	190	294,700:1	16,000
Fatty Acid	2,680	20,900:1	52,000
Amine	530	105,700:1	21,000
Kerosene	450	124,400:1	10,000
Sulfuric acid	3,040	18,400:1	17,000

SOURCE: MOBIL

TABLE 2-2

FLOW REQUIREMENTS FOR EACH WATER USE

Water Use	New Water (mgd)	Recycled Water (mgd)	Total Water Usage (mgd)
Slurry Transport Water	0	27.0	27.0
Pump Seal Water	0.691(1)	0	0.691
Washing/Dilution Water	0	52.0	52.0
Rinsing and Feed Preparation Water	0	38.0	38.0
Flotation Process and Makeup Water	15.7(2)	40.2	55.9
Miscellaneous Potable Water	0.022(1)	-	0.022
Total	16.413	157.2	173.613

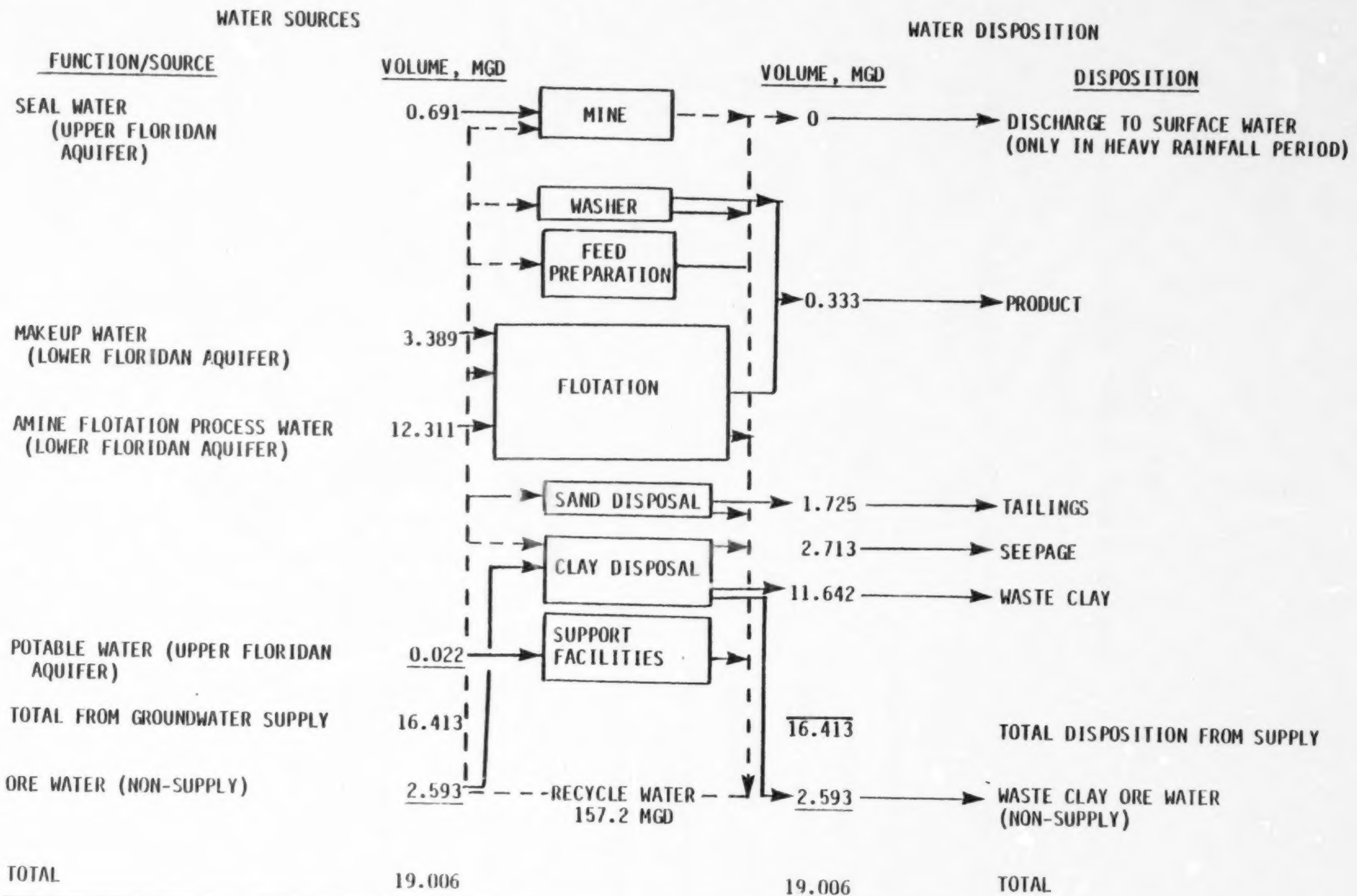
(1) Upper Floridan Aquifer

(2) Lower Floridan Aquifer

SOURCE: MOBIL

TABLE 2-3

MINE WATER BALANCE



SOURCE: MOBIL

TABLE 2-4

ACREAGES, DAM HEIGHTS, FILL LEVELS AND RECLAIMED ELEVATIONS FOR CLAY SETTLING AREAS

(Conventional Plan)

				Elevation Relative To Existing Grade			
Area	Total Acreage	Sand Capped Acreage	Uncapped Acreage*	Dam Height (ft.)	Clay Fill Level (ft.)	Approximate Reclaimed Elevation (ft.) for Capped Portion	Approximate Reclaimed Elevation (ft.) for Uncapped Portion
CS-1	780	653	127	45	40	45	--
CS-2	540	427	113	45	40	45	--
CS-3	840	--	840	45	40	--	34
CS-4	385	60	325	45	40	45	34
CS-5	300	60	240	45	40	45	34
CS-6	750	143	607	35	30	35	25
CS-7	735	146	589	35	30	35	25
CS-8	620	--	620	35	30	--	25
CS-9	400	--	400	35	30	--	25
CS-10	1,020	--	1,020	35	30	--	26
CS-11	690	--	690	35	30	--	25
CS-12	520	--	520	35	30	--	25
CS-13	590	--	590	40	35	--	30
CS-14	520	--	520	25	-3	--	-4
CS-15	993	--	993	0	-3	--	-4
Total	9,683	1,489	8,194				

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* Uncapped acreage includes both dam acreage and interior acreage without a sand cap.

Average dam height = 38.7 feet

SOURCE: MOBIL

TABLE 2-5

ACTIVE SETTLING ACREAGE OF ABOVE-GRADE BASINS

(Conventional Clay Settling Plan)

Settling Area	Acreage	Begin Clay Fill (Mine Year)	Complete Clay Fill (Mine Year)	Active Settling Acreage
CS-1*	780	1	4	780
CS-2*	540	3	4	1,320
CS-3	840	3	8	840
CS-4**	385	8	15	385
CS-5**	300	9	15	685
CS-6**	750	10	15	1,435
CS-7**	735	12	15	2,170
CS-8**	620	14	15	2,760
CS-9	400	15	16	400
CS-10	1,020	16	18	1,020
CS-11	690	18	20	690
CS-12	520	20	21	520
CS-13	590	21	23	590

* CS-1 and CS-2 would be operated by the flow through settling technique.

** CS-4, CS-5, CS-6, CS-7, and CS-8 would be operated by the flow through settling technique.

SOURCE: ZELLARS-WILLIAMS

TABLE 2-8

ANNUAL RECLAMATION SCHEDULE
(Conventional Plan)

Year	Areas Reclaimed	Acreage Reclaimed During Year	Reclaimed Acreage Cumulative Total
1			
2	OF-1	25	25
3			
4	OF-2	32	57
5			
6			
7			
8	TF-1	20	77
9	TF-2, CS-1, TF-3	1,064	1,141
10	OF-3	32	1,173
11	TF-4, CS-2	671	1,844
12	TF-5	135	1,979
13	OF-4, TF-6	293	2,272
14	TF-8	40	2,312
15	TF-7, CS-3	1,155	3,467
16	TF-9	286	3,753
17	OF-5, TF-10	390	4,143
18	TF-11	135	4,278
19	TF-12, OF-6, TF-13, TF-14	389	4,667
20	TF-15	365	5,032
21	OF-7, TF-16, TF-17	1,007	6,039
22	OF-8, TF-18, TF-19, TF-20	704	6,743
23	TF-21, CS-4, CS-5, CS-8, CS-9	1,825	8,568
24	TF-22	230	8,798
25	CS-6, CS-10	1,770	10,568
26	CS-7	735	11,303
27	CS-11	690	11,993
28	CS-12	520	12,513
29	TF-23, Plant Site, RR, and CWP	578	13,091
30	CS-13	590	13,681
31			
32			
33	CS-14	520	14,201
34	CS-15	993	15,194

SOURCE: MOBIL

3.0 METEOROLOGY, AIR QUALITY AND NOISE

3.1 THE AFFECTED ENVIRONMENT

3.1.1 EXISTING AIR QUALITY

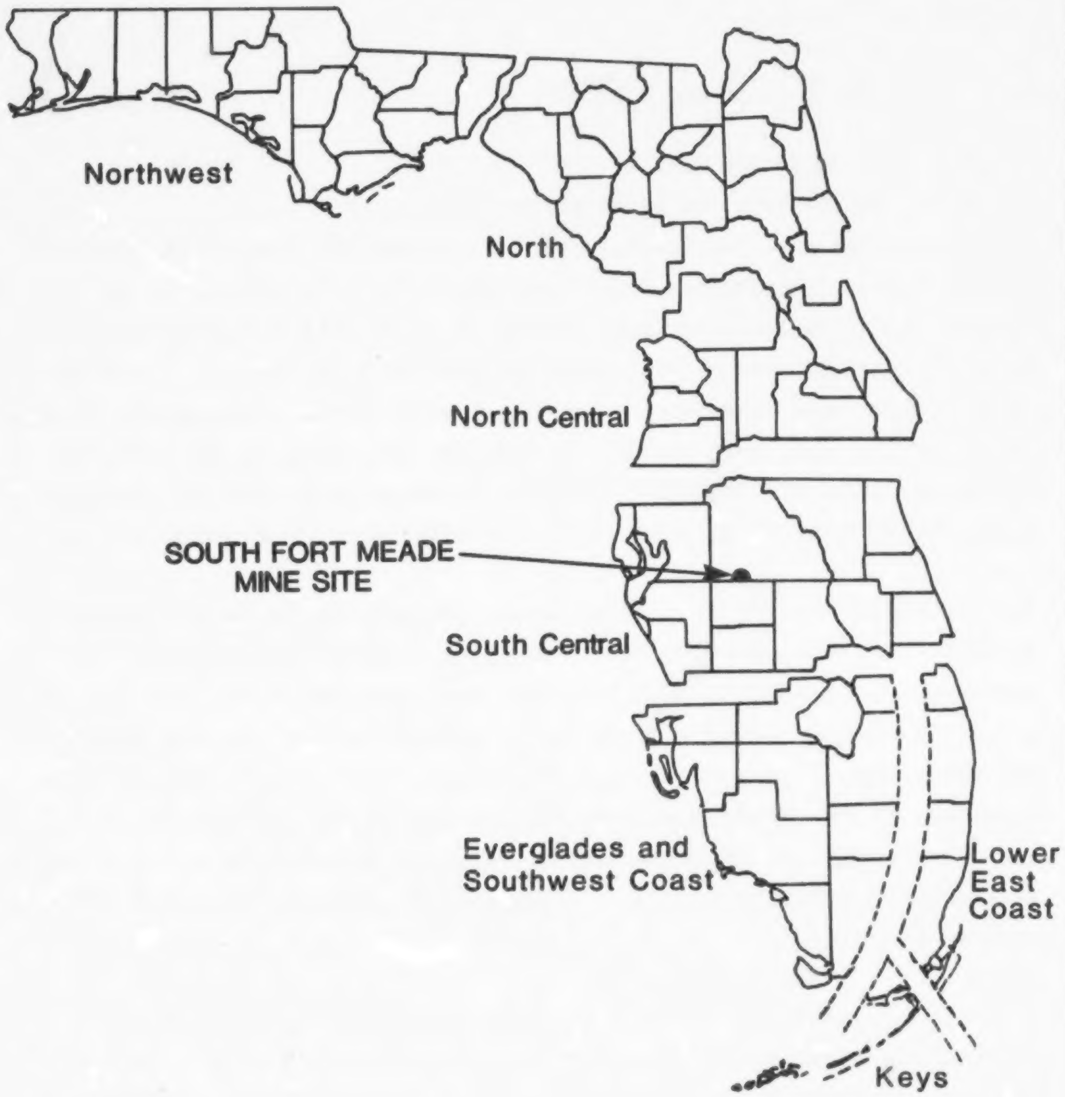
3.1.1.1 Meteorology and Climatology

The National Weather Service has divided Florida into seven climatological districts with the proposed South Fort Meade Mine site located in the subtropical climate of the South Central District (Figure 3-A). This district is characterized by hot, humid summers and mild winters. Freezing seldom occurs more than once or twice each year; winter temperatures average 62°F. During the summer months, the average temperature is typically 81° F. The annual average temperature is 73°F. Climatological data for Lakeland, the National Weather Station nearest the mine site, are summarized in Table 3-1.

A Climatronics electronic weather station was utilized to gather meteorological data at the South Fort Meade Mine site. Ambient temperature, relative humidity, wind speed, and wind direction were measured at the site for one year. In addition to the meteorological monitoring station, four Bendix ESD Model 775C universal rain gauges were installed. Figure 3-B shows the locations of the meteorological monitoring station and the rain gauges. Table 3-2 summarizes the precipitation data. The meteorological data were not statistically summarized for this study but are generally typical of the south central district.

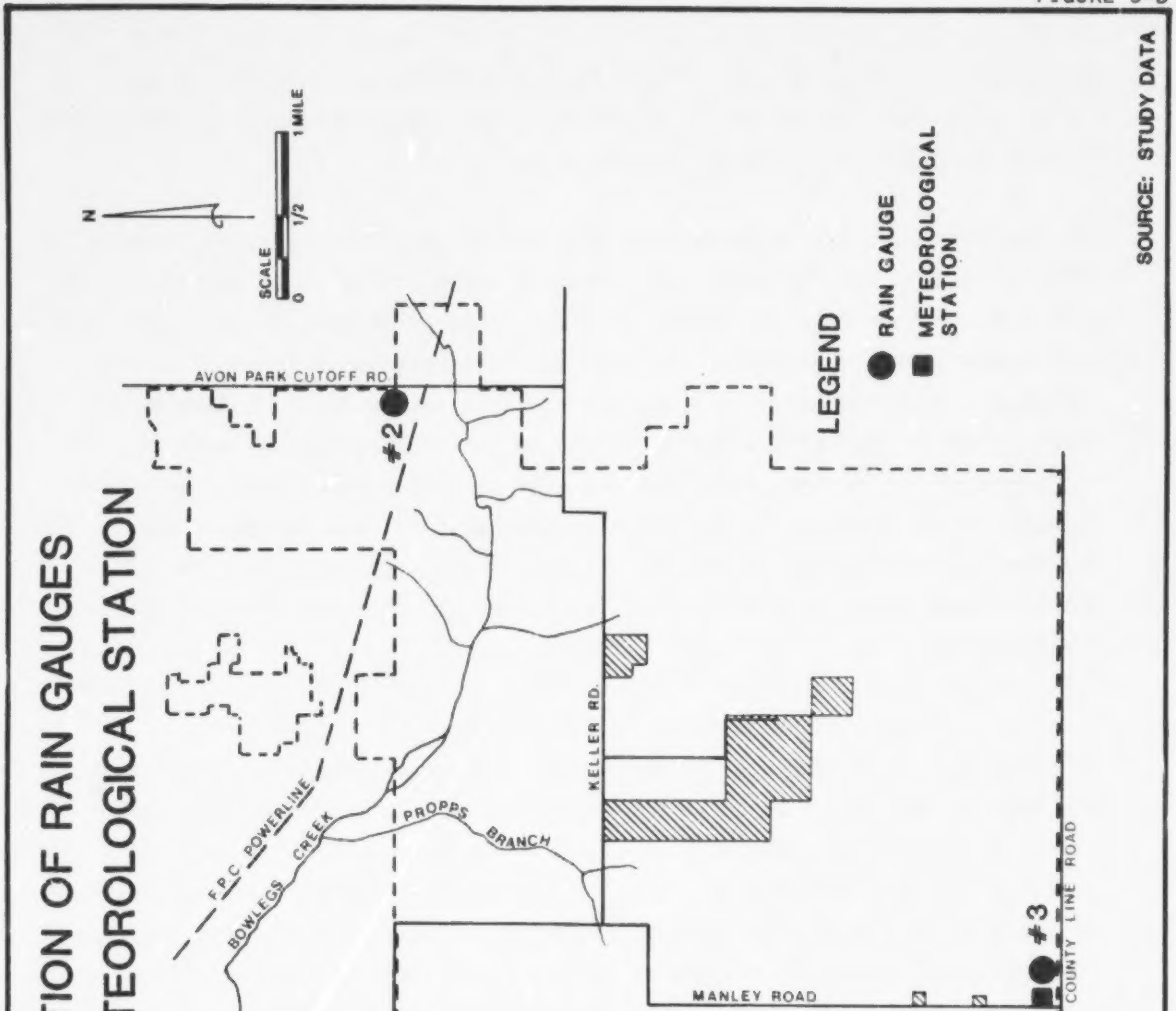
Rainfall is plentiful throughout the year with 53-54 inches of annual rainfall, heaviest during the months of June through September. The area experiences about 100 thunderstorms each year, occurring most frequently in the summer. Central Florida's humidity is moderate to high year-round, as

CLIMATOLOGICAL DISTRICTS OF FLORIDA



SOURCE: EPA, 1978

FIGURE 3-B



LOCATION OF RAIN GAUGES AND METEOROLOGICAL STATION

SOURCE: STUDY DATA

would be expected in an area with high precipitation and subtropical temperatures. The humidity is usually highest at dawn (about 90 percent), and lowest in the early afternoon (about 55 percent).

Air movement over the South Central District is generally constant, with winds prevailing from the northeast and averaging six miles per hour during most of the year. Winter cold fronts may generate winds of 20-30 miles per hour, but the highest winds observed in the area are associated with tropical storms, hurricanes or tornadoes. In these cases, winds have exceeded 100 miles per hour. Florida typically experiences one or two tropical storms each year usually approaching the state from the east or southeast in August and September, and shifting to the south or southwest in late September and October. Tornadoes may be spawned in association with tropical storms; however, they most frequently occur in the spring. Florida averages 10-15 tornadoes each year.

3.1.1.2 Dispersion Characteristics of the Local Atmosphere

The important climatological elements which govern the dispersion, dilution, and ambient concentration of potential air pollutants are wind speed, atmospheric stability and the thickness of the mixed layer. The concentrations of pollutants at any receptor site also depend on the steadiness and persistence of the wind direction affecting that receptor. These factors, when properly combined, can be used in dispersion models to estimate the concentrations of nonreactive pollutants at any point in space.

The wind parameters of interest are routinely observed and recorded at National Weather Service first-order stations and at numerous military airports. The stability class, calculated from these routine observations, can be categorized according to the rate of change of temperature with height, as follows:

(1) Stable, in which the rate of change of temperature with height is greater than the adiabatic rate, and the vertical dispersion of pollutants is inhibited.

(2) Neutral, in which the rate of change of temperature with height is equal to the adiabatic rate, and the vertical dispersion of pollutants is normal.

(3) Unstable, in which the rate of change of temperature with height is less than the adiabatic rate, and the dispersion of pollutants is enhanced.

These basic categories have been further divided into subclasses, designated A through F, in which A is the most unstable class, F is the most stable class, and D is the neutral class. The three parameters of wind speed, wind direction, and stability class are combined into a three-way joint frequency distribution of 16 wind directions, six wind speed classes, and six stability classes.

The joint frequency distributions (STAR programs) for Orlando and Tampa, the stations nearest the site, are summarized in Tables 3-3 and 3-4. As can be seen, both stations' distributions show a prevailing wind direction from the north through the east. The Tampa data show that prevailing wind directions are primarily from the east-northeast through the east, one-fourth of the observations being from those directions. Mean wind speeds from both stations are similar, but Orlando reports a greater percentage of neutral stability conditions, reflecting its more continental weather regime. The high percentage of stable conditions reported by both stations is typical for regions in the southeastern United States. These stable conditions occur most frequently on clear nights. Because vertical dispersion of pollutants is inhibited during stable conditions, ground-level concentrations of pollutants emitted from ground-level sources will tend to increase, while ground level concentrations of pollutants emitted from elevated sources will tend to decrease.

The mixed layer, defined in terms of the mixing height, is the air space between ground level and a level aloft through which the atmospheric pollutants are distributed. The upper limit of the mixed layer is defined by a layer of relatively stable air which prevents or retards further vertical dispersion of pollutants. The stable layer may be an actual temperature inversion through which virtually no vertical dispersion occurs, or a layer, somewhat less stable than an inversion layer, which will permit some vertical dispersion. A low mixing height results in a decreased volume within which pollutants may be dispersed, causing potentially higher pollutant concentrations.

A method for determining the height of the mixed layer from routine upper air sounding information has been developed by the National Weather Service and is summarized below (Holzworth, 1972).

	Mean Mixing Heights	
	Morning	Afternoon
Spring	600 m	1600 m
Summer	700	1500
Autumn	500	1400
Winter	500	1100
Annual	575	1400

These moderate mixing heights, combined with almost constant winds, give central Florida ventilation characteristics that are favorable to the rapid dilution of pollutants.

3.1.1.3 Air Pollution Control Regulations

There are both state and Federal regulations which may apply to air pollution control at the proposed South Fort Meade Mine site. Federal regulations include:

(1) Ambient Air Quality Standards (40 CFR, Part 50). All sources of pollution must comply with Federal ambient air quality standards for sulfur dioxide, suspended particulate matter, nitrogen dioxide, ozone, hydrocarbons, and carbon monoxide. The Federal standards for pollutants of concern to the proposed mine are given in subsequent sections of this section.

(2) Prevention of Significant Deterioration (PSD) (Clean Air Act, Part C, 42 FR 5749, 42 FR 57471, 42 FR 57479). This regulation requires that state implementation plans (SIP's) be revised to include requirements which will prevent significant deterioration of air quality in areas which meet the ambient air quality standards (attainment areas). EPA issues the PSD permit if the state has not been granted this authority. If a proposed new source has the potential to emit 250 tons per year of any pollutant regulated by the Clean Air Act, excluding fugitive emissions, then a PSD permit may be required

before construction can commence. The potential for emissions from the South Fort Meade Mine site will determine the applicability of the PSD regulations.

Applicable Florida regulations include:

(1) Ambient Air Quality Standards (Florida Administrative Code [FAC], Chapter 17-2.06). All sources of air pollution must comply with Florida's ambient air quality standards for sulfur dioxide, suspended particulate matter, nitrogen dioxide, ozone, hydrocarbons, and carbon monoxide. The Florida standards for pollutants of concern to the proposed mine are given in subsequent sections of this document.

(2) Best Available Control Technology (FAC, Chapter 17-2.03). All new sources must apply the best available control technology (BACT) to minimize emissions.

(3) Fugitive Particulates (FAC, Chapter 17-2.05[3]). Reasonable precautions must be taken to prevent and minimize the emissions of fugitive particulate matter to the atmosphere.

(4) Prevention of Significant Deterioration (FAC, Chapter 17-2.04). PSD is defined for major new emission sources. If the proposed mine is determined to be a major new emission source, a PSD permit may be required.

(5) Permitting (FAC, Chapter 17-4.03). Any new stationary source must obtain a valid construction or operating permit before commencing such activities. This requires the completion of air pollutant source construction permit applications for each source.

3.1.1.4 Areawide Pollutants of Concern

The major industrial sources of pollutants in the region are from electric utilities and the phosphate industry (EPA, 1978). The primary air pollutants associated with the phosphate industry are sulfur dioxide, dust, soluble and insoluble fluorides, and radon-222. The pollutants result from the following activities:

(1) Sulfur dioxide originates primarily from the burning of sulfur-containing fossil fuels and the manufacture of sulfuric acid from elemental sulfur (Pedco, 1976a and EPA, 1977).

(2) Dust is generated by fuel-burning, drying, grinding, and material transport, as well as by some stages of mining (Pedco 1975, 1976a, 1976b).

(3) Fluorides arise from various chemical processes, drying and calcining, fluoride removal for feed preparation, and gypsum and cooling water ponds at chemical plants (ESE, 1977 and Tessitore 1975, 1976).

(4) Radon-222 is the radioactive decay product of uranium-238, which is found in phosphate deposits. The disturbance of the ground formations by mining activities leads to a redistribution of the uranium and its decay products (Guimond and Windhame, 1975). This is discussed in detail in the radiation section.

3.1.1.5 Air Pollution Sources

The Areawide EIS summarizes both point and area sources of air pollution for seven counties in central Florida. Point sources are discrete, stationary sources such as stacks. Area sources include both mobile sources (road vehicles, aircraft, locomotives, etc.) and those small point sources which may be more conveniently aggregated into one emission value and considered to emanate from an area (residential heating, agricultural tilling, etc.). Major point sources within the Areawide EIS study area are identified in Table 3-5 and point source emissions of particulates and SO_2 are summarized by county in Table 3-6. Hillsborough County point sources are dominated by the power industry, while Polk County point sources are dominated by the phosphate industry. Table 3-7 summarizes both point and area sources by county. Point sources dominate in Polk and Hillsborough Counties; area sources dominate in the other five counties. Area sources of particulates are largely from highways and agricultural activities, while area sources of SO_2 are mostly from highways and citrus heating.

Major industrial point sources of air pollution within 15 miles (25 kilometers) of the proposed South Fort Meade Mine site are listed in Table 3-8. This information, obtained from the State of Florida Air Permit Inventory System, shows that the major industrial sources in the area are from phosphate processing operations. Major emissions are particulates, SO_2, and fluorides.

Point sources of particulates in the area are largely from the combustion of fossil fuels and the drying, grinding and transportation of material containing fine particulates. Particulates from fossil fuel combustion may range from negligible amounts for natural gas and some light fuel oils to higher amounts for heavier grades of fuel oil and coal. Particulates from drying, grinding and transportation consist of fugitive dust in the immediate area of these activities.

Major sources of SO_2 emissions in the area result from the combustion of fossil fuels containing sulfur and the production of sulfuric acid. The SO_2 emissions from fossil fuel combustion are dependent on the sulfur content of the fuel. The sulfur content can reach two to three percent in fuel oils, and can exceed three percent in coal. Both SO_2 and acid mist are emissions from the process of converting pure sulfur into sulfuric acid (H_2SO_4). In this process, the sulfur is burned to form SO_2, which is catalytically oxidized to SO_3 and hydrated to form H_2SO_4.

Both point and area sources of fluorides are associated with the phosphate industry (Tessitore, 1975 and 1976). Point sources of fluoride emissions include fertilizer chemical plants, defluorination plants, dryers, grinders and transfer operations. Fertilizer processing produces the water-soluble gases hydrogen fluoride (HF) and silicon tetrafluoride (SiF_4) as well as some insoluble fluoride containing particulates. The soluble gases are released in the production of normal and triple superphosphate, normal and superphosphoric acid, diammonium phosphate and elemental phosphorus. The defluorination of phosphate rock to produce animal feed is another source of water-soluble fluoride gases. Defluorination involves heating the rock to 2900°F to drive off fluoride products and reduce the fluoride concentration from 3.5 percent to approximately 0.5 percent. Phosphate rock drying, which involves heating the rock to 800-1200°F, drives off some soluble gases and particulates containing fluorides. Phosphate rock grinding and transfer points release fluoride-containing particulates that are generally insoluble in water.

Area sources of fluoride emissions are the gypsum and cooling-water ponds associated with phosphate chemical plants. The water in the ponds contains relatively high concentrations of fluorides generated by the manufacture of phosphoric acid and by the scrubber water used to clean various gas streams before they exit the plant. Some of these soluble fluorides are volatile and may be transferred to the atmosphere at the pond surface.

3.1.1.6 Total Suspended Particulates

Five high volume air samplers were operated at the South Fort Meade Mine site to measure the baseline levels of total suspended particulates (TSP). Figure 3-C shows the locations of the high volume samplers. Samplers 3 and 5 were located at the same station as part of the quality assurance program. Data were collected from February 14, 1979, to February 27, 1980, and are summarized in Table 3-9. National and Florida ambient air quality standards for TSP are shown below (40 CFR 50, FAC 17-2):

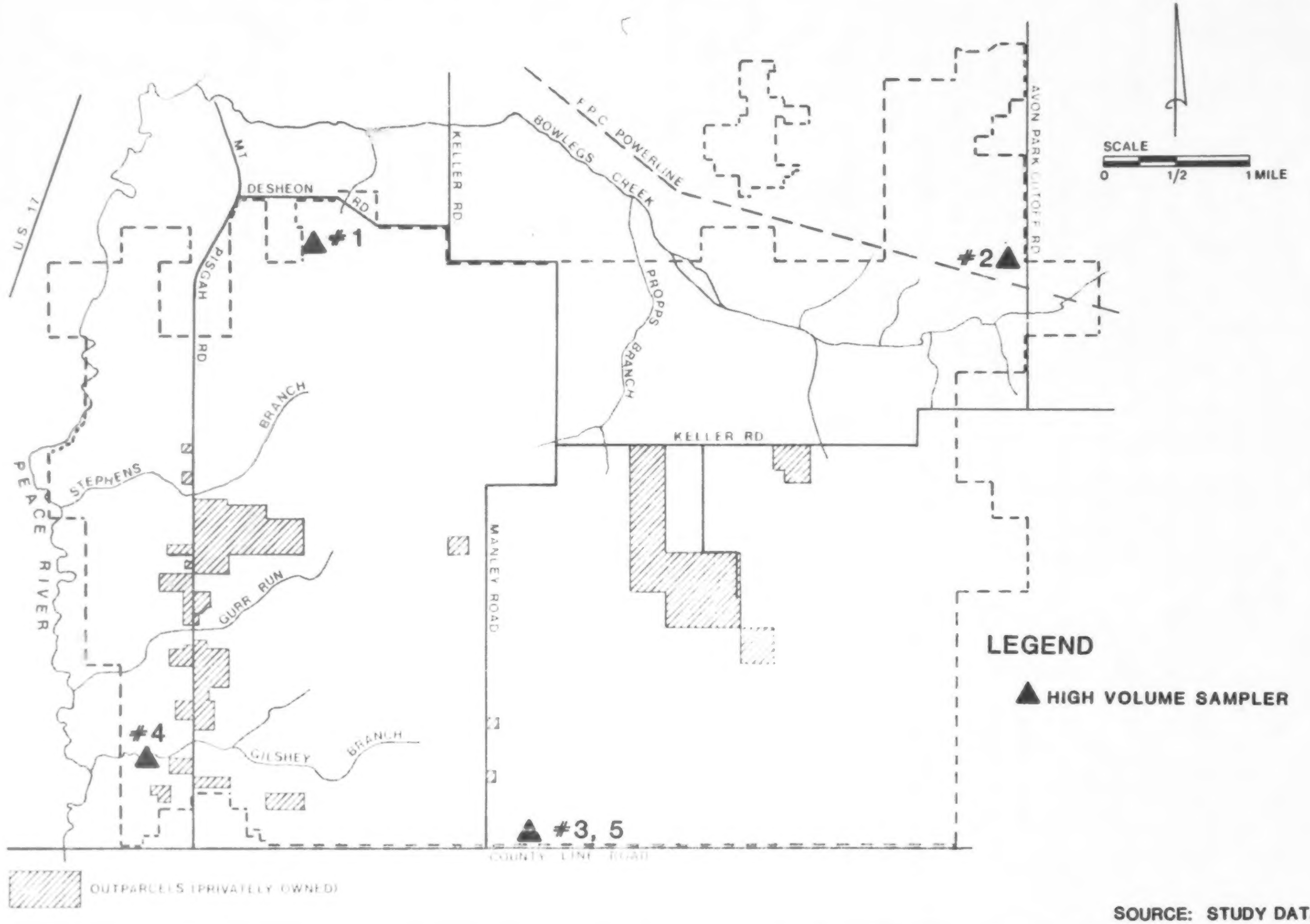
	National		
	Primary (ug/m^3)	Secondary (ug/m^3)	Florida (ug/m^3)
Annual geometric mean	75	60	60
24-hour maximum concentration not to be exceeded more than once per year	260	150	150

Primary standards define the level of air quality necessary to protect the public health. Secondary standards define the level which the EPA administrator judges necessary to protect the public welfare, including the protection of sensitive vegetation and other biota.

All measured concentrations of TSP were well below the Florida and Federal ambient quality standards. The maximum 24-hour concentration of 72 ug/m^3 was measured June 26-July 2, 1979, at station 1. The highest annual geometric mean was 29 ug/m^3, also measured at station 1. This annual geometric mean is approximately 50 percent of Florida's TSP annual standard and about 40 percent of the national primary standard.

FIGURE 3-C

LOCATION OF HIGH VOLUME SAMPLERS



SOURCE: STUDY DATA

A county-wide summary of the TSP data collected for the central Florida Phosphate Industry Areawide Impact Assessment Program is presented in Table 3-10. These data indicate a background level of TSP of 20-40 ug/m^3 in the counties shown. CF Industries data in Hardee County showed values of 23-45 ug/m^3 in an undeveloped area subject only to agricultural traffic and some premining activity. The high readings measured in DeSoto County can be partially attributed to an unfortunate choice in the location of the monitoring station; the apparent high levels probably do not reflect the levels existing throughout the county. TSP concentrations were high and fairly constant from 1972-1976 in Hillsborough County, the most developed county in the study area. Polk County, which exceeded state standards for the annual geometric mean for three years, has shown an improvement in TSP concentrations since 1974. This decline in ambient TSP levels may be largely due to the pollution control devices that the phosphate industry has applied to dusty operations since 1974.

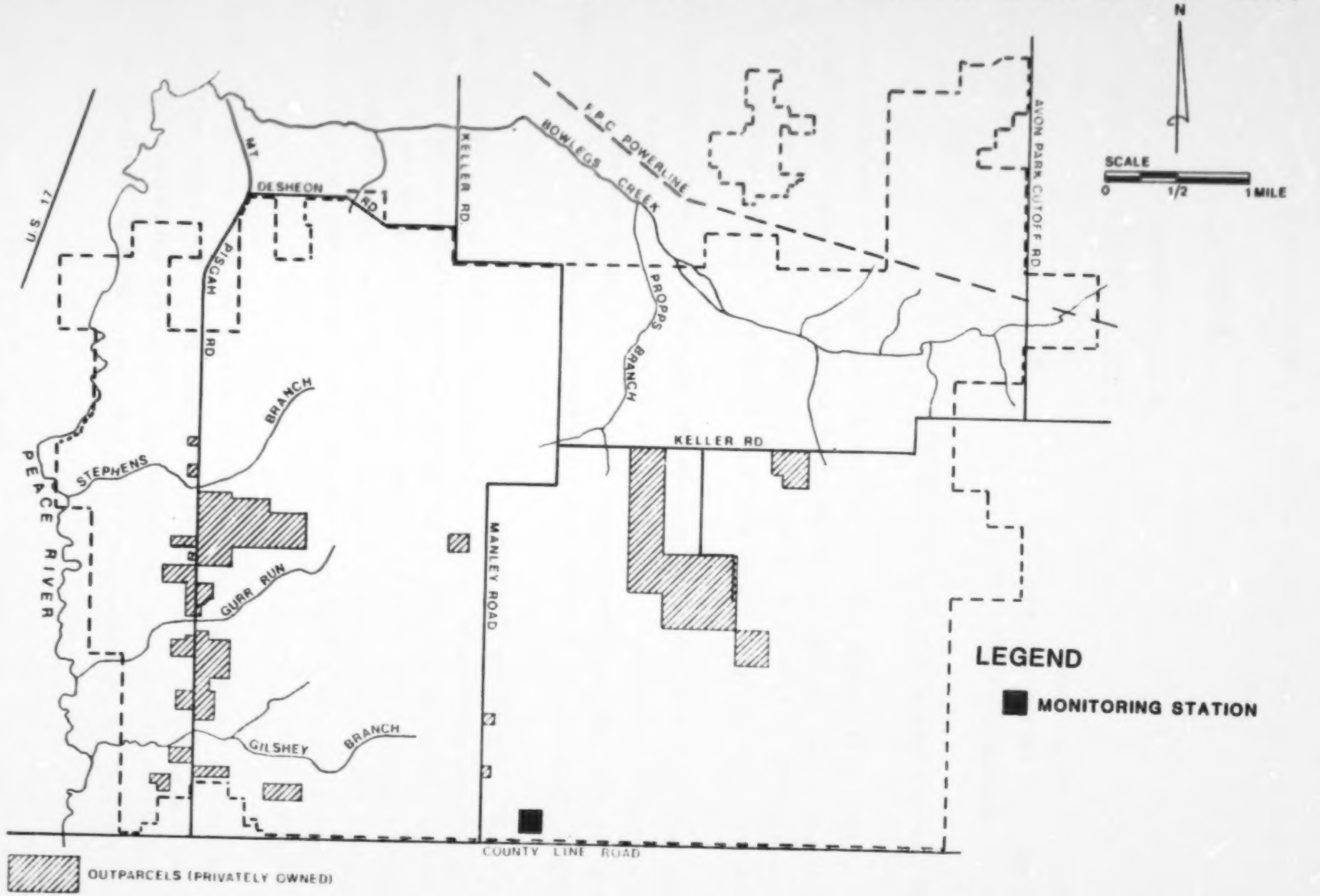
The data collected at the South Fort Meade Mine site compare favorably with the data discussed in the Areawide EIS, closely approximating the values measured in undeveloped areas. Thus, the baseline TSP concentration measured at the proposed mine site can be considered representative of typical undeveloped areas in central Florida and demonstrate that the location is attaining the state and Federal air quality standards for this pollutant.

3.1.1.7 Sulfur Dioxide

A Thermo Electron Model 43 continuous SO_2 analyzer was operated from June 13, 1979 to February 29, 1980 at the proposed mine site to provide background data on SO_2 concentrations. The location of the analyzer is shown in Figure 3-D. A statistical summary of the data is given in Table 3-11. The maximum one-hour concentration measured was 377 ug/m^3 and occurred July 2, 1979, at 8:00 a.m. The maximum three-hour concentration was 234 ug/m^3 and occurred on the same date, from 7:00 a.m. to 10:00 a.m. The maximum 24-hour concentration of 90 ug/m^3 occurred from 5:00 p.m., February 27 to 5:00 p.m., February 28, 1980.

FIGURE 3-D

LOCATION OF SULFUR DIOXIDE CONTINUOUS MONITORING STATION



SOURCE: STUDY DATA

The national and Florida ambient air quality standards for SO_2 are summarized below (40 CFR 50, FAC 17-2):

	National		
	Primary (ug/m^3)	Secondary (ug/m^3)	Florida (ug/m^3)
Annual arithmetic mean	80		60
24-hour maximum concentration*	385		260
3-hour maximum concentration*		1,300	1,300

*Not to be exceeded more than once per year

A comparison of Tables 3-11 and 3-12 shows that none of the measured concentrations of SO_2 exceeded the standards at any time. The annual mean SO_2 concentration of 6.56 ug/m^3 at the site is approximately 10 percent of the Florida annual standard and 8 percent of the national annual standard.

The South Fort Meade Mine SO_2 data are representative of the data reported in the Areawide EIS (Table 3-12). Hillsborough and Polk Counties have the highest averages, but show apparent declines in concentration since 1974. DeSoto, Manatee, and Sarasota Counties average less than 12 ug/m^3 county wide.

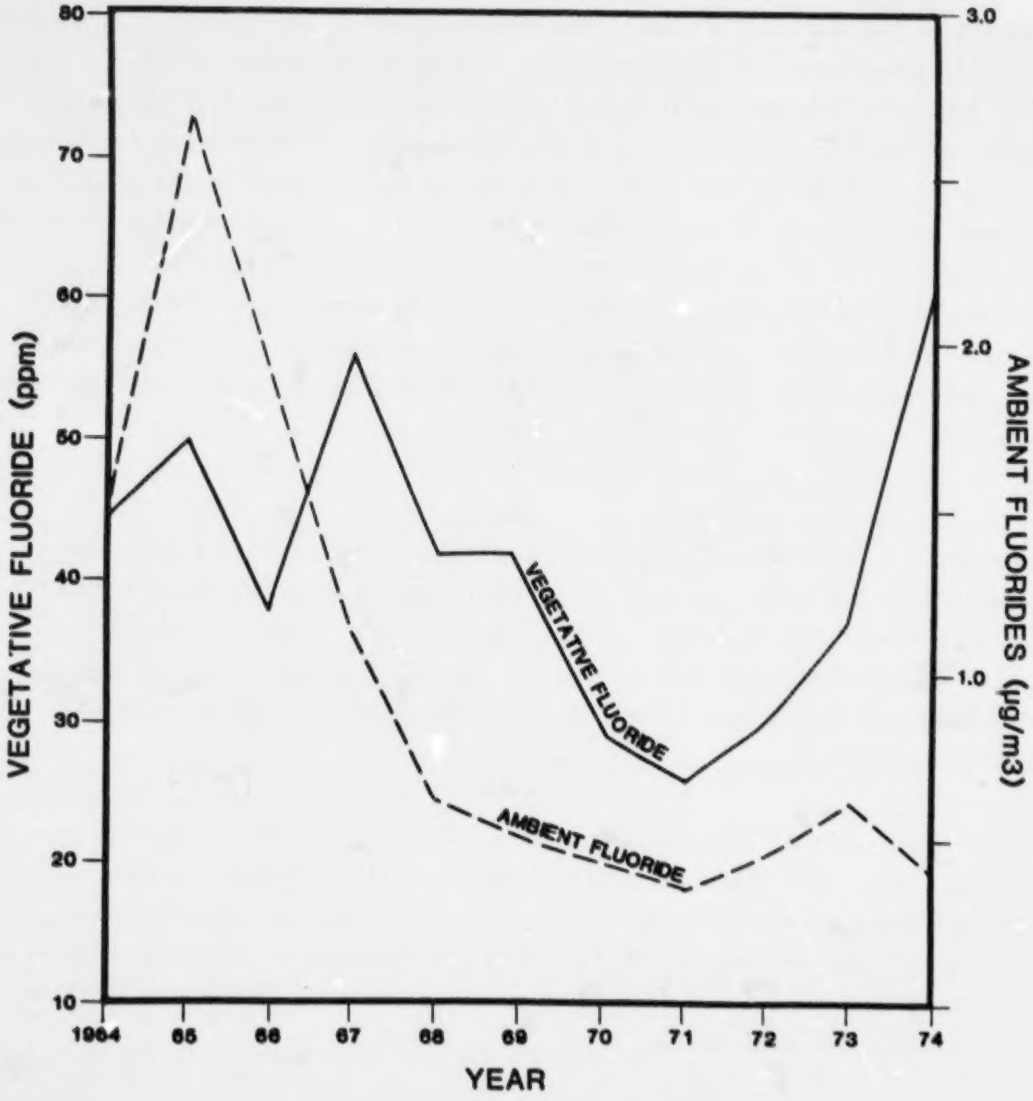
3.1.1.8 Vegetative Fluorides

The effects of fluorides on plants and animals in the vicinity of emission sources came under scrutiny in the early 1960's to the extent that the State of Florida began a program to analyze the fluoride concentration in pasture grasses (Tessitore, 1975). Fluorides have been associated with the fluorosis of cattle and with citrus and ornamental crop damage (Tessitore, 1976, Cross and Ross, 1969).

The State of Florida has designated a fluoride level of 45 ug/g as the limit that can safely be ingested by cattle without harm. This value includes fluorides both in and on the vegetation. Vegetative and ambient fluorides are illustrated for Polk County in Figure 3-E. While emission standards for

FIGURE 3-E

VEGETATIVE AND AMBIENT FLUORIDES IN POLK COUNTY



SOURCE: Tessitore, 1976

soluble and gaseous fluorides have been set by the state to minimize the effects of fluorides on vegetation, large individual or combined smaller sources can still raise vegetative levels above 45 ug/g.

Four sets of vegetation samples from the area surrounding the proposed mine site were analyzed for vegetative fluorides. The samples included pasture grass, citrus leaves and soil from pasture and citrus areas. The locations where vegetation and soil were collected are shown in Figure 3-F, and the results of the analyses of these samples are shown in Table 3-13. The maximum fluoride level measured at the site was 39.6 ug/g, 88 percent of the Florida standard. The average level for the vegetative samples was 11.5 ug/g, about 25 percent of the standard. This level is far below those reported for Polk County in the Areawide EIS. The high fluoride levels shown in the Areawide EIS are concentrated about 10 miles north of the proposed mine site. Also, the Areawide EIS study reports that there has been a tendency toward a decrease in size of those areas exceeding the 45 ug/gm limit, due to better control of emissions. If the trend toward lower vegetative fluoride levels has continued, lower concentrations at the South Fort Meade Mine site would be expected.

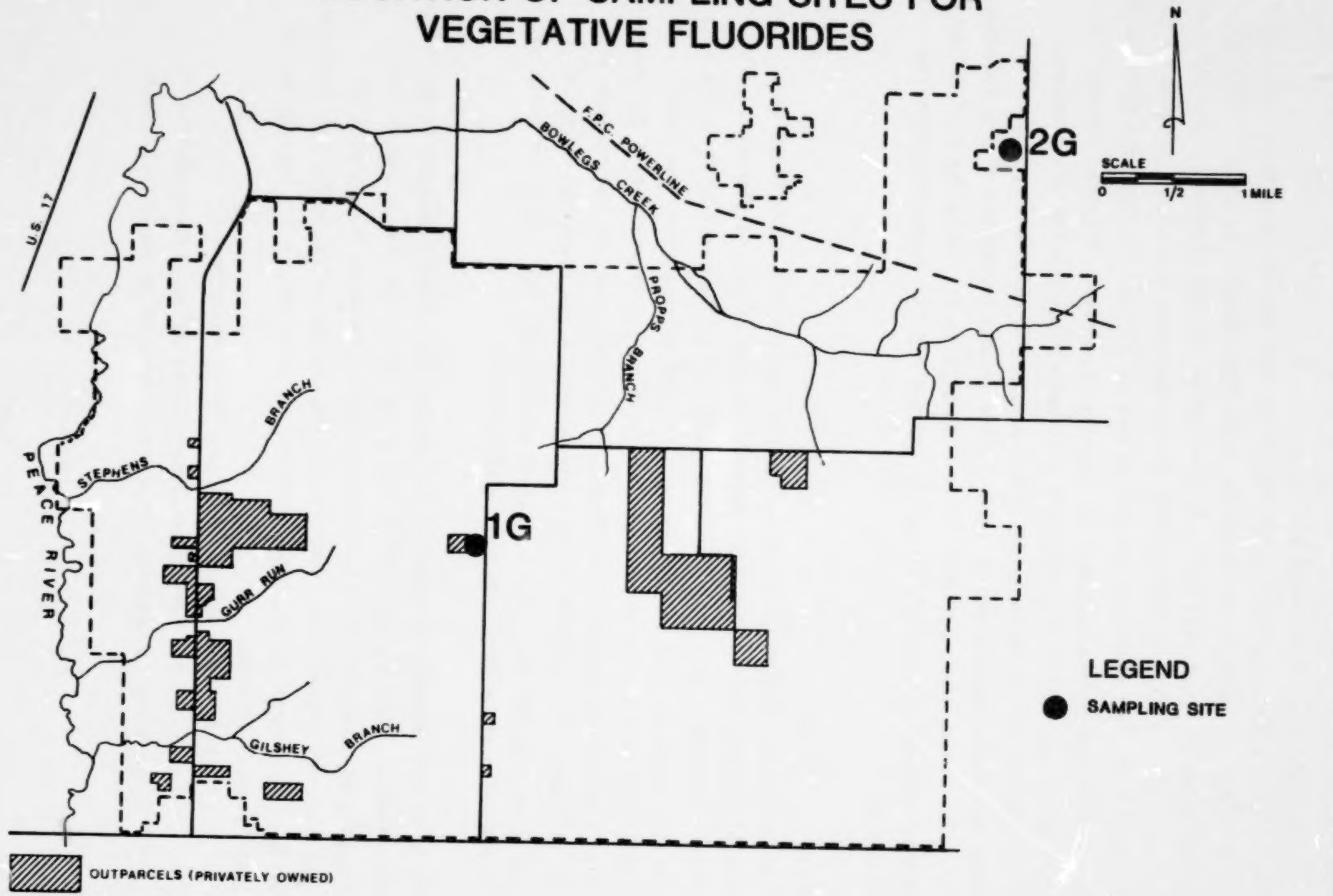
3.1.1.9 Quality Assurance

An extensive quality assurance program was instituted to comply with EPA requirements for technically acceptable air quality data for PSD air monitoring (Federal Register May 10, 1979, Appendix A). A quality assurance manual was prepared and followed for the determination of suspended particulates in the atmosphere, meteorological monitoring and continuous sulfur dioxide monitoring.

The program included methods for and required frequency of equipment calibration, sampling, laboratory analysis and reporting of data. Systems audits were performed quarterly by the third-party EIS consultant and indicated satisfactory performance of the equipment and operations. Both the quality assurance manual and the audit reports were reviewed by EPA (Appendix A) and are available for examination.

FIGURE 3-F

LOCATION OF SAMPLING SITES FOR VEGETATIVE FLUORIDES



SOURCE: STUDY DATA

3.1.1.10 Summary of Existing Air Quality

Particulate matter, sulfur dioxide and fluorides are the pollutants of concern in the areas surrounding the proposed South Fort Meade Mine site. The major contributors of these pollutants in the region are the phosphate industry and the electric utilities. The results of the one-year monitoring program at the proposed mine site show that concentrations of TSP and SO_2 are well below both the Florida and Federal ambient air quality standards. Measured concentrations of vegetative fluorides are also well below the Florida standard. These results are characteristic of concentrations which were measured in rural and undeveloped areas in central Florida and documented in the Areawide EIS. Therefore, the South Fort Meade Mine site is attaining the Florida and Federal ambient air quality standards and the Florida vegetative fluoride standard.

3.1.2 NOISE

Whenever a non-natural noise intrudes upon the ambient noise there is a possible degradation of the environment. Unlike other environmental pollutants, however, this potential degradation does not occur as a result of a specific residue. The collection and analyses of noise data are based upon established routines unique to this pollutant. The assessment of the ambient noise environment is based upon kinds of noise present and the perception of the auditors. The problem of defining excessive environmental noise is complicated by the fact that little is known about the effects of noise at levels below those that interfere with speech.

There is considerable variability in the way individuals respond to the noise environment. This variability in the perceived noise levels and in the response of human beings contributes to the differences on the part of "typical" individuals when sampled on a day-to-day or individual-by-individual basis. In general terms, types of noise to which people are exposed may be classified as follows:

(1) Steady-State Noise - When used in an environmental context, the term quasi-steady-state noise is more applicable. This may be described as a continuous noise whose sound level

remains essentially constant (fluctuations are slow and negligibly small) during the period of observation. Examples of sources of steady-state noise are power transformers, electrical generating stations, waterfalls, and turbines.

(2) Fluctuating Noise - This is continuous and exhibits variations in sound level. It may be described as cyclic though not necessarily periodic. Examples of sources of fluctuating noise are many industrial processes, highways, airports, radios, and televisions.

(3) Intermittent Noise - Intermittent noise may be described as discontinuous and, in most cases, varying in sound level. This would include many industrial proceses, construction work, occasional aircraft flyovers, and highways with light traffic.

The term most commonly used to describe noise levels is the decibel (dB). The decibel is actually a logarithm of the ratio of one sound pressure value to a reference sound pressure value, in micronewtons per square meter. The relationship defining decibels requires that if one sound pressure level (L) is twice another, the resultant decibel increase is six; if one sound pressure level is 100 times another, the increase is 40 decibels. Since it has been shown that the human ear does not hear all frequencies equally well, a number of weighting schemes have been applied to sound pressure level measurements. The most common is the A-weighting scale. This scale is thought to most accurately represent the capacities of the human ear. The decibel values reported in the following section are all A-weighted measures.

3.1.2.1 Standards and Regulations

EPA is in the process of developing source noise emission standards for a variety of products (portable air compressors, construction equipment, trucks, automobiles, etc.). Other Federal agencies have promulgated noise regulations specific to their respective area of interest. Two of the more pertinent Federal noise standards and regulations are discussed in the following sections.

U.S. Environmental Protection Agency: As directed by the Noise Control Act of 1972, EPA has published a document which reflects "the scientific knowledge most useful in indicating the kind and extent of all identifiable effects of noise on the public health and welfare which may be expected from differing quantities and qualities of noise" (EPA, 1973). EPA has also published a document in which the noise descriptors L_{eq} and L_{dn} were employed to describe the effects of environmental noise (EPA, 1974). The energy mean noise level (L_{eq}) is the "level of the steady-state continuous noise having the same energy as the actual time varying noise measured in A-weighted decibels" (EPA, 1973). L_{dn} is the equivalent day-night A-weighted sound level and is defined as the A-weighted average sound level in decibels during a 24-hour period with a 10 dB weighting applied to the nighttime sound levels. Table 3-14 presents a summary of noise levels that EPA has identified as being requisite to protect public health and welfare with an adequate margin of safety. Table 3-15 presents a summary of the possible community reactions to an area with an outdoor L_{dn} of 55 dBA. Of particular interest is the fact that EPA considers the 55 dBA value to be "7 dBA below the level of significant 'complaints and threats of legal action' and 16 dBA below 'vigorous action'." The 62 dBA "complaints and threats" level and the 71 dBA "vigorous action" level represent orders of magnitude increases in the actual sound pressure levels observed. Approximately one percent of the listeners will complain at the 55 dBA level. At the 65 dBA level, approximately five percent of the population will complain. The "adequate margin of safety" for outdoor environments is between seven and ten decibels above the L_{dn} value presented in Table 3-14.

U.S. Department of Housing and Urban Development: The U.S. Department of Housing and Urban Development (HUD) has promulgated a policy and minimum standards which require that noise exposure be given adequate consideration in connection with all HUD programs which provide financial support to planning (HUD, 1971). This HUD policy is intended to provide assurance that new housing and other noise sensitive accommodations will not be planned for areas whose current or projected noise exposures exceed the specified standards.

The HUD external noise exposure standards for new construction sites are expressed in terms of the acceptability of the site based on measured or projected noise exposures (24 CFR 51.103). In part, the HUD external noise exposure standards state that a new construction site is:

- Acceptable - if the L_{dn} do not exceed 65 dBA
- Normally unacceptable - if the L_{dn} are above 65 dBA, but do not exceed 75 dBA
- Unacceptable - if the L_{dn} exceed 75 dBA

The acceptable site would be consistent with the EPA levels previously presented, considering EPA's adequate margin of safety. Regulations and criteria relating to exposure to and control of environmental noise address not only noise levels that can produce hearing loss but also noise levels that contribute to the neighborhood "quality of life."

There are no local or state ordinances, regulations, or standards which regulate environmental noise in the area of the site. Therefore, noise exposure limits designed for the protection of employees in the workplace are the only existing control on facility noise emissions. The EPA and HUD guidelines do, however, provide a useful basis for assessing existing environmental noise at the South Fort Meade Mine site and evaluating possible impacts from the implementation of the proposed action.

3.1.2.2 Noise Measurement and Data Reduction

The methodology used for this study and the procedures followed were in compliance with the applicable standards of the American National Standards Institute (ANSI), and were developed to provide the desired environmental noise descriptors. The necessary form of the data required that the noise measuring equipment have the capability of providing an A-weighted sound level output. The frequency response is required by the ANSI Standard S1.4 and is designed to and is generally accepted as correlating well with the frequency response characteristics of the human ear.

The noise measurement procedure utilized can be described as follows:

(1) At each measurement site, the microphone was on a tripod-mounted boom at a height of approximately four feet above ground level, connected to the sound level meter by an extension cable which allowed the observer to be out of the field of influence of the device.

(2) The sound level meter output was connected to a sound level recording device.

(3) Using an acoustic calibration signal, the entire data acquisition system (microphone to recorder) was calibrated, and the calibration signal was recorded on magnetic tape.

(4) Pertinent noise measurement site information, equipment scale settings, and the start and stop times of the measurement were noted.

(5) The site number and the meter settings were recorded at the beginning of each sample tape.

The following is a detailed list of the noise measuring equipment including serial numbers:

Description	Manufacturer/Type
Sound Level Meter	General Radio, type 1933 Precision Sound Level Meter and Analyzer, Serial Number 1178
Microphone	General Radio, type 1961 1-inch Electret-condenser Microphone, Serial Number 1535
Magnetic Tape Recorder	Nagra IV, Type SJS, Serial Number 2005

Each component of the data acquisition system was maintained in accordance with the manufacturer's instructions and checked periodically against noise level standards to ensure that it met or exceeded the applicable specifications.

The sound levels recorded on magnetic tape at each measurement site were in the form of unweighted analog signals. Since it was necessary to develop the L_{eq} and L_{dn} values for each measurement site, statistical analyses of the analog data were required. The first step in the data reduction process involved calibrating the data reduction system. The sound level meter was set for an A-weighted response, in this case a reading of 115 dBA when the upper scale was 120 dBA. This scale was then equivalent to the scale noted in the voice record.

The sound level meter was read every ten seconds until at least 50 points were taken and the statistical consistency was verified. Notes on the actual field data sheets indicate any special precautions taken to exclude unrepresentative noise.

The equivalent sound level (L_{eq}) for each sample is described by the following equation:

$$L_{eq} = L_{50} + 0.115s^2$$

where:

L_{50} = the noise level exceeded 50 percent of the time

s = the standard deviation of the noise level distribution

The day-night average sound level for each site was calculated using the following equation (EPA, 1974):

$$L_{dn} = 10 \log [15(10^{L_d/10}) + 9(10^{(L_n+10)/10})]/24$$

where:

$L_d = L_{eq}$ for the daytime (0700-2200 hours)

$L_n = L_{eq}$ for the nighttime (2200-0700 hours)

When processing the field-recorded noise data, it was occasionally desirable to omit certain segments or portions from the statistical analysis. This occurred when the actual act of taking the measurements caused sounds not normally occurring at the measurement site.

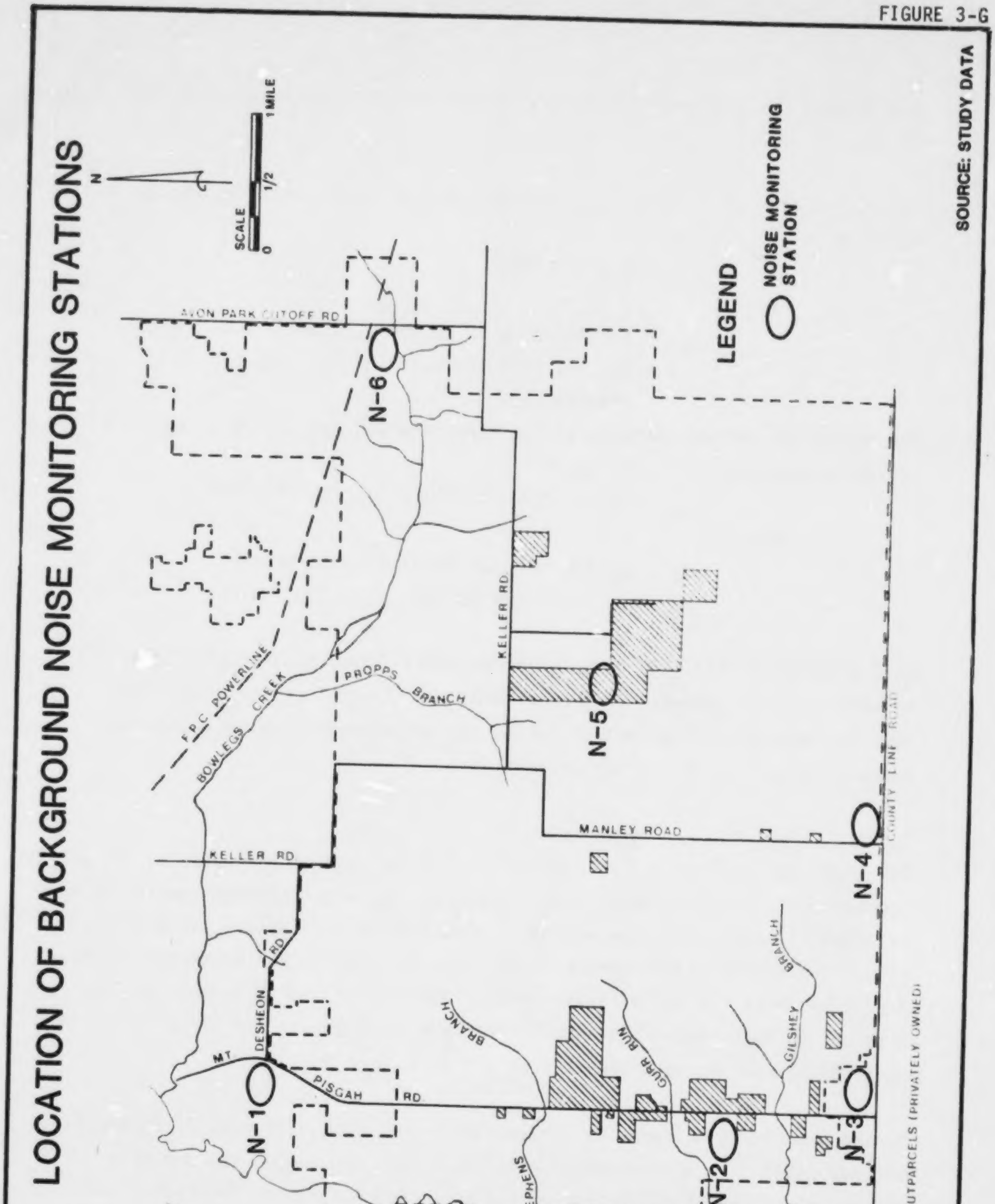
3.1.2.3 Noise Survey Results

The locations identified in Figure 3-G and Table 3-16 were sampled on the site between April 13th and 14th, 1980. Day, evening, and nighttime samples were recorded at each station on each day, resulting in six samples taken at each site. The statistical analyses of the recorded samples are presented in Table 3-17 along with the noise levels exceeded 10 percent and 90 percent of the time during each sampling event. These values illustrate the distribution of noise levels during each sampling period at each station.

During the nighttime sampling events, there were no significant differences between sound levels recorded on a weekend night and those recorded on a weekday night except at Station 5, the most remote sampling location. The weekday night sample L_{eq} was 8 dBA higher than the weekend night sample L_{eq}. Variations in the observed nighttime noise levels at such a remote location

FIGURE 3-G

LOCATION OF BACKGROUND NOISE MONITORING STATIONS



SOURCE: STUDY DATA

are probably due to natural phenomena (wind, insect activity, etc.). The weekend and weekday L_{eq} values for the daytime and evening sampling periods demonstrated no observed patterns of variation.

The calculated L_{dn} values did not vary significantly from site to site or by weekend or weekday sampling period. The highest L_{dn} value was calculated for Station 1. The lowest L_{dn} values were calculated for Stations 3 (weekend) and 4 (weekday). All of the calculated L_{dn} values were equal to or below those levels identified in Table 3-14 as "requisite to protect public health and welfare with an adequate margin of safety." The L_{dn} values for the stations on or adjacent to the proposed mine site are below the 65 dBA "acceptable" criteria used by HUD.

3.1.2.4 Quality Assurance

The reliability of the data presented was assured through the use of precision sound level measuring and recording equipment, maintained to manufacturer's specifications. The observer followed a sampling program that minimized his own influence on the ambient noise environment. Data reduction and analysis were performed using accepted procedures.

3.2 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

3.2.1 THE NO ACTION ALTERNATIVE

The no action alternative would not increase air emissions or noise levels, and the site's air quality and noise characteristics would likely remain as they currently are. However, emissions from any new sources in the area permitted in the future and/or changes in fuels used at existing sources may change the air quality of the South Fort Meade site.

3.2.2 THE ACTION ALTERNATIVES INCLUDING THE PROPOSED ACTION

3.2.2.1 Mining Method Alternatives (See description DEIS 2.2)

Dragline (Mobil's Proposed Action): The electrically powered draglines would not generate point source combustion emissions of air pollutants. Small quantities of fugitive dust may be generated during overburden removal and matrix extraction, but because these mined materials would be generally wet, dust emissions would occur only in isolated cases when surface areas become dry. Vehicular traffic from operations and maintenance personnel on roadways in the mining area would constitute line sources of air pollutant emissions consisting of carbon monoxide (CO), nitrogen oxides (NO_x) and hydrocarbons. Ground level emissions of fugitive dust would also be generated by this traffic flow. These impacts would be insignificant since the emissions would be intermittent and would be confined primarily to the proposed mine site.

The mining method requires that 50-acre parcels be cleared ahead of each dragline, which would result in fugitive dust and emissions of particulates, CO, and hydrocarbons from open burning of vegetative debris. Approximately 30 percent of the total land area at the site (4,500 acres) has vegetation requiring clearing and disposal. The impact of this clearing would be minimal because the emissions would be intermittent and the rural setting would allow for the rapid dispersion of pollutants. All burning activity connected with land clearing would be regulated by permits from the state.

According to the results of the noise monitoring program conducted as part of Estech's environmental assessment (EPA, 1979a), noise levels between 55 and 62 dBA are expected at a distance of 200 feet from an operating electric dragline. Under a "worse case" situation (highest recorded sound level on site and the highest noise level for an operating dragline) an L_{dn} value of 68 dBA could occur at the South Fort Meade Mine property line. This maximum noise level is greater than the U.S. Department of Housing and Urban Development's (HUD) normally unacceptable threshold of 65 dBA, but less than HUD's unacceptable level of 75 dBA. The maximum value is expected to occur off site only if the dragline is operating 200 feet or less from the property line. Traffic associated with the construction and operation of the mine would not significantly affect the existing noise environment.

Bucket Wheel: The bucket wheel, like the dragline, would be electrically powered and would not generate point source combustion emissions. However, the potential for fugitive dust emissions associated with this method would be greater than with dragline operations since the drier pit conditions required favor increased wind erosion of the soil. Bucket wheel mining would also require a larger cleared area than the dragline method, further increasing fugitive dust emissions. Open burning of vegetation would generate emissions in approximately the same quantities as the dragline operation. Mining with a bucket wheel would require additional handling of the overburden through conveyors which could potentially increase fugitive dust and would generate greater noise levels than the dragline mining method.

Dredge: The electrically powered dredge would not generate point source combustion emissions of air pollutants. Fugitive dust emissions would be negligible since excavation is done underwater and overburden and matrix are moved as slurry. Potential dust emissions would be further reduced by the flooding of the cleared acreage. Open burning of vegetation would generate emissions in approximately the same quantities as the dragline operation. Mining by dredge would affect noise levels in the same way as the dragline method.

3.2.2.2 Matrix Transfer Alternatives (See description DEIS 2.3)

Pipeline (Mobil's Proposed Action): No fugitive dust emissions would be associated with the pipeline transfer of wet slurry. Because the slurry pumps would be driven by electric motors, pumping would not result in any point source emissions at the site. The electric booster pumps would be the only source of noise associated with this matrix transfer system. The noise generated by the pumps would not contribute to the off-site noise environment for three reasons: (1) the pumps would be widely spaced along the pipeline route, (2) the pipeline route itself would be away from the property boundaries, and (3) the pump stations would be low noise generation sources. A peak sound pressure level of 68 dBA for the combination of a dragline and slurry pit pipeline has been measured (EPA, 1979a).

Conveyor Transport: The potential exists for minor fugitive dust emissions from the conveyor operation since the surface material could dry at times during transfer. Unless the conveyor is contained or covered, fugitive dust emissions would occur along the transport corridor. A conveyor system would generally be noisier than a pipeline system. Based on a recent study, L_{dn} levels on the order of 70 dBA could occur at a distance of 175 feet from an operating conveyor (Farmlands, 1981). The principal source of noise from a conveyor system is the movement of the belts and rollers, generating noise along the entire length of the conveyor route. Since the route of the conveyor system would be away from the property boundaries, the off-site exposure to conveyor system noise should be minimal. Levels on the order of 60 dBA would occur at 1,250 feet.

Truck: Several potential sources of air pollution are associated with this transfer method. The trucks' engines would exhaust NO_x, CO, hydrocarbons and particulate matter during transit as well as during idling periods while waiting to be loaded. Emissions of fugitive particulate matter would be generated throughout the entire transfer process (truck loading by the dragline, vehicular traffic on the haul roads, erosion losses during open-bed truck transport and truck dumping at the ultimate destination). The continuous construction of haul roads to accommodate this transfer method would further increase the generation of fugitive dust.

The trucks required to move the ore from the mining area to the beneficiation plant would generate greater noise levels than the other transfer methods. The magnitude of such noise would depend on the location of the mining area and the truck transport route. The impact would be greatest during nighttime hours. Currently there is little truck-generated noise on local roads during nighttime hours.

3.2.2.3 Matrix Processing Alternatives (See description DEIS 2.4)

Conventional Beneficiation (Mobil's Proposed Action): None of the component operations of conventional beneficiation are considered to be major air pollution sources. There are no combustion sources and no drying processes that involve the blowing of air through product or waste material. Wind erosion losses from product dumping into rail cars or pebble storage piles may result in minor amounts of fugitive dust emissions; however, the use of water as a transfer medium and the moist nature of the product would prevent fugitive dust from becoming a problem. The impact of the dust generated would be negligible by the time it reaches Mobil's property boundary.

Transfer and storage of some of the flotation reagents could result in emissions of volatile organic compounds (VOC). For example, when a kerosene tank is filled, vapor in the tank headspace would be vented to the atmosphere. Similar emissions are also possible from storage and transfer of fatty acids, Transfer and storage of some of the flotation reagents could result in emissions of volatile organic compounds (VOC). For example, when a kerosene tank is filled, vapor in the tank headspace would be vented to the atmosphere. Similar emissions are also possible from storage and transfer of fatty acids, amines and No.6 fuel oil. These potential emissions would be quite small, however, due to the low vapor pressures of the materials stored on site.

Based on the Estech study, the conventional beneficiation plant is expected to generate noise levels between 70 and 75 dBA at a distance of approximately 200 feet. The property boundary nearest the beneficiation plant is approximately 3,300 feet away. Noise generated by the operation of the plant would be attenuated to between 46 and 51 dBA over that distance, not considering the additional attenuating characteristics of groundcover, foliage, and man-made or natural barriers. Therefore, the contribution of the conventional beneficiation plant to the off-site noise environment will not affect even the nearest potential receptor.

Dry Separation: The dry separation process would create a significant source of air pollutant emissions as a result of drying large quantities of matrix which would require combustion of substantial volumes of fuel oil. Combustion of the fuel oil would generate emissions of SO_2 dependent on the sulfur content of the fuel. Some fuel oils are characterized by relatively high concentrations of vanadium (approximately 200 ppm) which act to catalyze the formation of sulfuric acid from SO_2. The dry separation process thus poses the added potential for emissions of acid mist, with the attendant plumes of high opacity. Particulate matter entrained in the dryer exhaust gases would have to be removed before discharge to the atmosphere. Oxides of nitrogen (NO_x) emissions are a major concern from any combustion-related drying process.

The dry separation process requires the use of dry mining matrix transfer methods which increases the fugitive dust impacts. The crushing and sizing operations required prior to drying would generate large amounts of fugitive dust. Blowers used to separate the matrix would add to the levels of TSP near the plant site.

3.2.2.4 Waste Disposal and Reclamation Alternatives (See description DEIS 2.5 and 2.6)

Conventional Clay Settling Case (Mobil's Proposed Action): Earthmoving operations would generate fugitive dust and combustion emissions as impoundments are built, land is leveled and topography is restored. Nine pieces of earthmoving equipment are projected to be used at the South Fort Meade Mine. Their emissions and associated fugitive dust would rapidly disperse over the open mine site, resulting in a negligible impact. During the period between mining and reclamation of any given area, the barren landscape may give rise to fugitive dust emissions. The maximum size of this area is estimated to be 745 acres during Phase II with two working draglines. After one year, revegetation of the barren areas will occur through natural seeding, providing temporary cover until reclamation and revegetation.

Mobil proposes to use six scrapers, two bulldozers and one grader, each with a peak noise level at 50 feet of 87 dBA, 86 dBA, and 84 dBA, respectively. Using a noise prediction methodology developed by the Federal Highway Administration for heavy equipment operation, day-night equivalent noise levels adjacent to dam construction areas will increase while such activities are in progress. Earthmoving equipment for dam construction would normally be operated during the daytime for 8 to 10 hours each weekday. Dam construction is not expected to occur any closer than 200 feet from any receptor. During a dam construction period, therefore, equivalent noise levels 200 feet from a dam construction site will be approximately 75 dBA, assuming no attenuation due to groundcover, foliage and man-made or natural barriers. At various locations adjacent to the site, L_{dn} values will exceed 65 dBA, a level considered by the U.S. Department of Housing and Urban Development (HUD) to be "normally unacceptable". However, dam construction activities will not cause L_{dn} values to exceed 75 dBA, HUD's "unacceptable" level. After completion of a dam wall, noise levels on adjacent properties will return to preconstruction levels because the dam walls will, in effect, serve as a sound barrier to subsequent mine-related noises. The short-term noise impact of waste disposal and reclamation activities could be significant for several weeks to nearby residents. The impacts would be intermittent, however, occurring only during daylight hours. The long-term noise impact will be negligible.

Sand/Clay Cap Case: The sand/clay mix (4:1) cap alternative for reclamation would have approximately the same air and noise impacts as the conventional settling and reclamation alternative.

Sand/Clay Mix Case: This case for waste disposal and reclamation would have the same impacts on the air resources and noise environment as the conventional case.

Overburden/Clay Mix Case: Impacts on the air resources and noise levels would be greater with this case than with the conventional case because of the additional earthmoving equipment and mixers required.

3.2.2.5 Plant Siting Alternatives (See description DEIS 2.8)

Gilshey Branch (Mobil's Proposed Action): The proposed Gilshey Branch plant is located at the centroid of pumping distances for the proposed mine site and adjacent to an existing road which would provide easy access to the processing plant (Figure 1-B). The minor emissions from conventional processing would not carry beyond the site's boundaries. The location of the plant would have little or no impact on the noise environment of adjacent off-site property.

Other On-Site Locations: Other on-site plant locations are not expected to substantially change the emissions from the plant itself, although increased vehicle traffic miles created by additional travel distances would result in greater quantities of roadway dust and vehicular emissions. Moving the plant site closer to the property boundaries would increase the impacts on adjacent properties.

3.2.2.6 Product Transport Alternatives (See description DEIS 2.10)

Railroad (Mobil's Proposed Action): Mobil proposes to transport product on a new, six-mile railroad spur constructed from the beneficiation plant to the main railroad line west of the mine site (Figure 2-M). The train would make two daily round trips. The nearest residence to the track alignment is 405 feet north of the track with the next closest residence 820 feet south of the track. Based on the "Noise Assessment Guidelines" prepared by HUD, neither residence location will have an L_{dn} greater than 55 dBA due to the operation of the railroad. This value is well below HUD's "normally unacceptable" level of 65 dBA. The train would emit air pollutants associated with fuel combustion (particulates, NO_x, CO and hydrocarbons), but these emissions would have a minor effect on local air quality.

Truck: Approximately 260 truck trips would be needed to transport the 6,500 tons of product carried by one train. The trucks would use about six times the energy required for rail transport and would result in a significant increase in emissions of air pollutants. If all the trucks use State Route 664 to enter and exit the mine site, the traffic-generated noise levels along the road segment between Mt. Pisgah Road and U.S. 17 would increase above the maximum recorded L_{dn} value of 55 dBA (Table 3-17). During the first phase of operation, L_{dn} values would be 65 to 66 dBA 100 feet from the roadway. During the second phase of mine operation, after mine production has doubled, the L_{dn} value at the same distance from the roadway would rise to 70 dBA.

3.3 REFERENCES

Cross, F.L. Jr., and R.W. Ross, 1969. New Developments in Fluoride Emissions from Phosphate Processing Plants, J. Air Pol. Contr. Assn., 19(1):15-17.

Environmental Science and Engineering, Inc., 1977. Evaluation of Emissions and Control Techniques for Reducing Fluoride Emissions from Gypsum Ponds in the Phosphoric Acid Industry, U.S. EPA Contract.

Farmlands Industries, Inc., 1981. Development of Regional Impact Application for Development Approval, Phosphate Mining and Chemical Fertilizer Complex, Hardee County, Florida.

Florida Department of Environmental Regulation, 1980. Air Permit Inventory System Detail List for Polk and Hardee Counties.

Guidmond, R.J. and S.T. Windhame, 1975. Radioactivity Distribution in Phosphate Products, By-products, Effluents, and Wastes, U.S. EPA Criteria and Standards Div. Tech. Note ORP/CSD-75-3:1-32.

Holzworth, G. C., 1972. Mixing Heights, Wind Speeds, and Potential for Air Pollution Throughout the Contiguous United States, prepared for U.S.EPA, Research Triangle Park, North Carolina.

Pedco Environmental Specialists, Inc., 1975. Particulate and Sulfur Dioxide Area Source Emission Inventory for Duval, Hillsborough, Pinellas, and Polk Counties, Florida, Vol. I, U.S. EPA Region IV.

Pedco Environmental Specialists, Inc., 1976a. Air Quality Modeling in Hillsborough, Pinellas, and Polk Counties, Florida, Vol. I, U.S. EPA Region IV.

Pedco Environmental Specialists, 1976b. Air quality Modeling in Hillsborough, Pinellas, and Polk Counties, Florida, Vol. II, U.S. EPA Region IV.

Pedco Environmental Specialists, Inc., 1977. Summary of Florida Ambient Air Quality Monitoring Data for 1972-1975, Florida Sulfur Oxide Study, Inc.

Tessitore, J.L., 1975. Fluoride Data for Polk County, Florida, DER.

Tessitore, J.L., 1976. An Estimate of Total Fluorides Emitted in the Polk-Hillsborough County Area, DER.

Texas Instruments, Incorporated, 1978. Central Florida Phosphate Industry Areawide Impact Assessment Program, prepared for the U.S. EPA, Atlanta, Georgia.

U.S. Department of Housing and Urban Development, 1971. Noise Abatement and Control; Departmental Policy Implementation, Responsibilities and Standards, Circular 1390.2.

U.S. Environmental Protection Agency, 1973. Public and Welfare Criteria for Noise, prepared by EPA office of Noise Abatement and Control (EPA 550/9-73-002).

U.S. Environmental Protection Agency, 1974a. Background Information for Standards of Performance: Phosphate Fertilizer Industry, Research Triangle Park, North Carolina (EPA 45-/2-74-019a).

U.S. Environmental Protection Agency, 1974b. Information on Levels of Environmental Noise (EPA 550/9-74-004).

U.S. Environmental Protection Agency, 1979. Noise Resource Document, Estech General Chemicals Corporation Draft Environmental Impact Statement. EPA 904/9-79-0440.

U.S. Environmental Protection Agency, Office of Air and Waste Management, 1977. Compilation of Air Pollutant Emission Factors, AF-2, Pt. A and B, 2nd Edition.

TABLE 3-1

CLIMATOLOGICAL SUMMARY FOR LAKELAND, FLORIDA

	Jan. (Winter)	April (Spring)	July (Summer)	Oct. (Fall)	Annual	Period of Record
Temperature (°F)						
Absolute maximum	85.0	95.0	101.0	89.0	86.0	1941-78
Mean maximum	70.5	81.8	90.4	82.4	81.3	1941-70
Mean	60.8	72.0	81.6	74.3	72.1	1941-70
Mean Minimum	51.0	62.1	72.7	66.1	62.9	1941-70
Absolute minimum	25.0	40.0	66.0	43.0	20.0	1941-78
Degree Days (65°F)						
Heating	188.0	9.0	0.0	0.0	678.0	1941-70
Cooling	58.0	219.0	515.0	288.0	3298.0	1941-70
Normal Precipitation (in.)	2.32	2.57	8.09	2.84	49.43	1941-70
Relative Humidity (%) For Orlando (Lakeland Data Unavailable)						
Morning	87.0	87.0	90.0	87.0	88.0	1964-78
Afternoon	56.0	45.0	59.0	56.0	55.0	1964-78
Average Wind Speed (MPH)	7.3	7.7	5.7	7.2	6.9	1967-78
Miscellaneous (Mean Number of Days)						
Clear	10	11	2	12	100	1941-78
Partly Cloudy	12	12	18	11	159	1941-78
Cloudy	9	7	11	8	106	1941-78
Temperature 32°F	1	0	0	0	2	1941-78
Precipitation 0.01 in.	7	6	18	8	120	1941-78

	Recurrence Interval					
	1 yr	5 yr	10 yr	25 yr	50 yr	100 yr
Maximum 24-hour Rainfall Intensity (inches)	4.0	6.5	7.5	9.0	10.0	11.0

SOURCE: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

TABLE 3-2

PRECIPITATION DATA FOR SOUTH FORT MEADE SITE

Month	Station Number	Number of Days Reported	Number of Rainy Days	Total Precipitation (inches)
March 1979	3	4	0	0
April 1979	3	30	2	1.40
May 1979	3	19	9	5.72
June 1979	3	14	5	2.35
July 1979	3	19	10	2.01
August 1979	3	29	15	7.53
September 1979	3	30	18	9.72
October 1979	3	31	2	0.40
November 1979	1	30	5	0.64
	2	26	2	0.93
	3	28	3	0.49
	4	30	5	0.84
December 1979	1	31	3	1.47
	2	21	1	0.26
	3	31	3	1.53
	4	31	3	1.40
January 1980	1	31	8	2.94
	2	31	8	1.87
	3	31	7	1.54
	4	31	7	1.99
February 1980	1	28	5	1.93
	2	28	5	2.20
	3	28	6	2.35
	4	28	6	1.83

SOURCE: STUDY DATA

TABLE 3-3

THREE-WAY FREQUENCY DISTRIBUTIONS ORLANDO, FLORIDA

JANUARY 1960 TO DECEMBER 1964

	Wind Speed Distribution (percent)								Stability Class					
Wind Direction	0-3 knots	4-6 knots	7-10 knots	11-16 knots	17-21 knots	>21 knots	Total (percent)	Average Speed	A	B	C	D	E	F
N	0.6	2.5	3.4	1.2	0.1	*	7.8	7.7	0.1	0.3	0.8	2.9	1.9	1.8
NNE	0.6	2.3	3.5	1.5	0.1	*	8.0	8.0	0.1	0.4	1.1	3.2	1.7	1.5
NE	0.7	2.9	2.9	1.3	0.1	0	7.9	7.6	0.1	0.4	1.1	3.1	1.4	1.8
ENE	0.6	3.2	2.5	1.6	0.1	0	8.0	7.8	*	0.4	0.9	3.2	1.3	2.1
E	0.7	2.4	2.1	1.6	0.1	*	6.9	8.1	*	0.3	0.9	2.9	1.2	1.5
ESE	0.6	2.4	2.1	1.2	0.1	*	6.4	7.7	0.1	0.4	0.7	2.5	1.2	1.4
SE	0.6	2.3	2.0	0.8	*	0	5.7	7.2	0.1	0.3	0.6	2.1	1.3	1.5
SSE	0.6	1.9	1.4	0.5	*	*	4.4	6.9	0.1	0.3	0.5	1.4	0.9	1.3
S	0.8	2.9	2.4	1.2	0.2	*	7.5	7.6	0.1	0.5	0.9	2.9	1.5	1.7
SSW	0.4	2.0	2.5	1.4	0.2	*	6.5	8.6	0.1	0.7	1.1	2.9	0.9	0.9
SW	0.6	2.2	2.2	0.9	0.1	*	6.0	7.7	0.1	0.5	1.0	2.2	1.0	1.2
WSW	0.4	1.5	1.8	0.9	0.1	*	4.7	8.2	*	0.3	0.8	1.9	0.8	0.9
W	0.3	1.2	1.4	0.9	0.2	*	4.0	8.7	*	0.3	0.6	1.7	0.7	0.7
WNW	0.2	1.1	1.9	1.7	0.3	*	5.2	9.8	0.1	0.3	0.8	2.6	0.9	0.7
NW	0.4	1.6	1.9	1.2	0.1	*	5.2	8.3	*	0.3	0.8	2.1	0.8	1.1
NNW	0.4	1.7	2.2	1.1	*	0	5.4	8.0	*	0.3	0.7	2.2	1.0	1.2
Total	8.5	34.1	36.2	19.0	1.8	0.2		7.7	1.0	6.0	13.3	39.8	18.5	21.3
Stability Class														
A	0.1	0.8	0	0	0	0								
B	0.8	2.8	2.4	0	0	0								
C	0.3	3.4	7.7	1.1	*	0								
D	0.4	4.3	15.9	17.4	1.8	0.2								
E	0	8.3	10.3	0	0	0								
F	6.8	14.6	0	0	0	0								

*Less than 0.05 but greater than 0.

SOURCE: NATIONAL WEATHER SERVICE

TABLE 3-4

THREE-WAY FREQUENCY DISTRIBUTIONS TAMPA, FLORIDA

JANUARY 1971 TO DECEMBER 1975

Wind Direction	Wind Speed Distribution (percent)								Stability Class					
	0-3 knots	4-6 knots	7-10 knots	11-16 knots	17-21 knots	>21 knots	Total (percent)	Average Speed	A	B	C	D	E	F
N	0.5	1.7	2.1	0.8	*	0	5.1	7.7	*	0.3	0.5	0.9	1.3	2.2
NNE	0.5	1.9	1.8	0.7	*	0	5.0	7.4	*	0.3	0.6	0.7	1.0	2.3
NE	0.8	2.6	2.2	1.1	*	*	6.7	7.4	*	0.2	0.7	1.2	1.3	3.4
ENE	1.3	4.2	3.4	1.1	*	0	10.0	7.0	0	0.3	1.2	1.6	1.5	5.5
E	1.8	6.8	5.1	1.7	*	0	15.3	7.0	*	0.7	1.8	2.5	2.5	7.9
ESE	1.0	3.0	2.6	0.9	*	0	7.6	7.0	*	0.4	0.9	1.3	1.3	3.7
SE	0.7	2.0	2.6	0.7	*	0	6.0	7.3	*	0.3	0.9	1.1	1.2	2.5
SSE	0.5	2.0	2.3	1.2	*	*	5.6	7.8	*	0.3	1.0	1.2	1.1	1.9
S	0.5	1.8	2.2	1.0	0.1	*	5.9	8.1	*	0.4	0.9	1.5	1.4	1.7
SSW	0.2	0.8	1.6	0.5	0.1	0	3.7	8.9	0	0.3	0.9	1.2	0.6	0.7
SW	0.3	1.2	1.3	0.7	*	0	3.4	7.6	*	0.5	0.8	0.6	0.4	1.0
WSW	0.2	1.0	2.1	2.7	*	0	4.0	8.1	*	0.7	1.2	0.8	0.5	0.7
W	0.5	1.5	4.3	1.0	*	0	9.0	9.1	*	1.0	2.6	2.6	1.2	1.6
WNW	0.3	1.1	1.3	1.0	0.1	*	3.8	8.9	0	0.2	0.5	0.9	0.8	1.3
NW	0.4	1.7	1.5	1.0	0.1	*	4.7	8.4	0	0.1	0.3	0.9	0.9	2.5
NNW	0.5	1.3	1.3	1.0	0.1	0	4.1	8.4	*	0.2	0.4	0.9	0.9	1.8
Total	10.0	34.6	37.7	17.0	0.9	0.1		7.4	0.2	6.2	15.2	19.9	17.9	40.7
Stability Class														
A	*	0.1	0	0	0	0								
B	0.7	2.7	2.8	0	0	0								
C	0.4	2.6	10.0	2.1	0.1	*								
D	0.1	2.6	6.5	10.1	0.6	0.1								
E	0.6	2.2	10.0	4.8	0.2	*								
F	8.2	24.2	8.3	0	0	0								

*Less than 0.05 but greater than 0.

SOURCE: NATIONAL WEATHER SERVICE

TABLE 3-5

MAJOR POINT SOURCES OF AIR POLUTION IN AREAWIDE STUDY AREA

Source	Category
Agrico-Pierce	Phosphate
Agrico-S. Pierce	Phosphate
Borden-Piney Point	Phosphate
Borden-Coronet, Plant City	Phosphate
Borden-Tenoroc	Phosphate
Brewster-Brewster Dry Mill	Phosphate
Brewster-Lonesome	Phosphate
CF Chemicals-Bonnie	Phosphate
CF Ind-Plant City	Phosphate
Conserv-Nichols	Phosphate
Electro-Phos-Pierce	Phosphate
Farmland-Green Bay	Phosphate
Gardinier-Tampa	Phosphate
Gardinier-Ft. Meade	Phosphate
W.R. Grace-Bartow	Phosphate
IMC-Bonnie	Phosphate
IMC-Kingsford	Phosphate
IMC-Noralyn	Phosphate
IMC-New Wales	Phosphate
IMC-Port Sutton	Phosphate
IMC-Prairie	Phosphate
Mobil-Nichols	Phosphate
Royster-Mulberry	Phosphate
Swift Chemical-Agricola	Phosphate
USS Agrichem.-Bartow	Phosphate
USS Agrichem.-Ft. Meade	Phosphate
FP&L-Manatee	Electric utility
Lakeland Utilities-Larsen	Electric utility
Lakeland Utilities-No. 3	Electric utility
TECO-Big Bend	Electric utility
TECO-Gannon	Electric utility
TECO-Hookers Pt.	Electric utility
American Orange	Miscellaneous
Ben Hill Griffin	Miscellaneous
C&M Products	Miscellaneous
Citrus World	Miscellaneous
Eastern Assoc. Term.	Miscellaneous
General Portland	Miscellaneous
Gulf Coast Lead	Miscellaneous
Mid-Florida Asphalt	Miscellaneous
Nitram	Miscellaneous
D.S. Prosser	Miscellaneous
Seaboard Coastline Term.	Miscellaneous
Selco	Miscellaneous
Standard Sand & Silica	Miscellaneous
Tampa Incinerator	Miscellaneous
Thatcher Glass	Miscellaneous
Tropicana	Miscellaneous
Warren Bros.	Miscellaneous

SOURCE: EPA, 1978

TABLE 3-6

POINT SOURCE EMISSION SUMMARY

County	Category/Year		Particulates Metric Tons/Yr	(T/Yr)	SO_2 Metric Tons/Yr	(T/Yr)
Charlotte	Misc	74/76	32	(35)	40	(44)
DeSoto	Misc	74/76	29	(32)	85	(93)
Hardee	Misc	74/76	37	(41)	114	(125)
Hillsborough	Phosphate	74	5,279	(5,807)	25,175	(27,692)
		76	2,262	(2,488)	17,875	(19,663)
	Electric	74	20,069	(22,076)	234,823	(258,305)
		76	3,831	(4,214)	213,218	(234,540)
	Misc	74	4,010	(4,411)	7,623	(8,385)
		76	1,816	(1,998)	7,555	(8,311)
	Total	74	29,358	(32,294)	267,620	(294,382)
		76	7,909	(8,700)	238,649	(262,514)
Manatee	Phosphate	74	104	(114)	628	(691)
		76	42	(46)	1,674	(1,841)
	Electric	76	276	(304)	3,801	(4,181)
	Misc	74	295	(325)	118	(130)
		76	295	(325)	118	(130)
	Total	74	399	(439)	746	(821)
		76	614	(675)	5,593	(6,152)
Polk	Phosphate	74	30,033	(33,036)	110,171	(121,188)
		76	6,809	(7,490)	37,149	(40,864)
	Electric	74	204	(224)	7,998	(8,798)
		76	295	(325)	6,987	(7,686)
	Misc	74	889	(978)	841	(925)
		76	1,023	(1,125)	944	(1,038)
	Total	74	31,125	(34,238)	119,010	(130,911)
		76	8,127	(8,940)	45,080	(49,588)
Sarasota	Misc	74/76	115	(126)	175	(192)
County Area	Total	74	61,095	(67,205)	387,789	(421,568)
		76	16,863	(18,549)	289,735	(318,708)

SOURCE: EPA, 1978

TABLE 3-7

SUMMARY OF POINT AND AREA SOURCE EMISSIONS IN AREAWIDE EIS STUDY AREA

County	Metric Tons Per Year			
	1974		1976	
	Particulates	SO_2	Particulates	SO_2
Charlotte				
Area sources	1,835	141	1,862	147
Point sources	32	40	32	40
Desoto				
Area sources	1,644	65	1,656	67
Point sources	29	85	29	85
Hardee				
Area sources	2,556	72	2,572	73
Point sources	37	114	37	114
Hillsborough				
Area sources	12,382	2,559	12,865	2,695
Point sources	29,358	267,620	7,909	238,649
Manatee				
Area sources	3,091	326	3,121	348
Point sources	399	746	614	5,593
Polk				
Area sources	10,983	841	11,199	901
Point sources	31,125	119,010	8,127	45,080
Sarasota				
Area sources	2,806	328	2,901	349
Point sources	115	175	115	175
Total				
Area sources	35,297	4,332	36,176	4,580
Point sources	61,095	387,790	16,863	289,736
All sources	96,392	392,122	53,039	294,316

SOURCE: EPA, 1978

TABLE 3-8

MAJOR POINT SOURCES OF AIR POLLUTION WITHIN 15 MILES (25 KILOMETERS) OF SOUTH FORT MEADE MINE SITE

Source	Category	Potential Pollutants Emitted
Hardee County		
American Orange	Citrus	TSP
Polk County		
Agrico (Chemical Plant, Mine)	Phosphate	TSP, SO_2, F
Alcoa (By-Product Recovery)	Phosphate	TSP, F
Ben Hill Griffin-Barton (Processing)	Citrus	TSP
CF Industries (Chemical Plant, Mine)	Phosphate	TSP, SO_2, F
Electro-Phos Corp. (Elemental P_4)	Phosphate	TSP, SO_2, F
Farmland (Fertilizer Plant)	Phosphate	TSP, SO_2, F
Gardinier (Mine)	Phosphate	TSP
IMC-Noralyn (Mine)	Phosphate	TSP
Kaplan (Processing)	Cattle feed	TSP, SO_2
Orangeco of Florida (Processing)	Citrus	TSP
Royster Company (Chemical Plant)	Phosphate	TSP, SO_2, F
Swift (Estech) (Chemical Plant, Mine)	Phosphate	TSP, SO_2, F
USS Agrichemicals-Bartow (Chemical Plant)	Phosphate	TSP, SO_2, F
USS Agrichemicals-Fort Meade (Chemical Plant, Mine)	Phosphate	TSP, SO_2, F
W. R. Grace (Chemical Plant, Mine)	Phosphate	TSP, SO_2, F

SOURCE: STATE OF FLORIDA AIR PERMIT INVENTORY SYSTEM

TABLE 3-9

TSP DATA FOR SOUTH FORT MEADE SITE

Period	Station Number	Number of Samples	24-Hour Concentration Maximum ($\mu g/m^3$)	24-Hour Concentration Second ($\mu g/m^3$)	Geometric Mean ($\mu g/m^3$)	Geometric Standard Deviation ($\mu g/m^3$)
02/14/79-04/28/79	1	13	68	56	41	1.4
	2	12	42	39	30	1.4
	3	10	45	42	33	1.4
	4	13	46	43	32	1.2
	5	9	47	44	33	1.3
05/03/79-07/26/79	1	12	72	57	34	1.5
	2	11	66	62	30	1.5
	3	12	65	64	27	1.6
	4	13	69	58	31	1.7
	5	11	64	62	26	1.7
08/01/79-10/31/79	1	15	46	41	22	1.6
	2	16	40	36	19	1.7
	3	13	44	44	21	1.8
	4	16	41	37	21	1.6
	5	13	43	42	22	1.7
11/05/79-02/27/80	1	20	48	37	26	1.4
	2	16	36	36	26	1.3
	3	17	55	37	27	1.4
	4	20	51	46	26	1.4
	5	17	57	38	27	1.4
02/14/79-02/2780	1	60	72	68	29	1.6
	2	55	66	62	25	1.6
	3	52	65	64	26	1.6
	4	62	69	58	27	1.5
	5	50	64	62	26	1.6

SOURCE: STUDY DATA

TABLE 3-10

COUNTY-WIDE AVERAGES FOR ANNUAL GEOMETRIC MEAN OF 24-HOUR TSP DATA

County	1972	1973	1974	1975	1976*
Charlotte	--	21	30	27	26
DeSoto	--	43	44	52	53
Hillsborough	50	51	53	50	51
Manatee	51	46	45	40	36
Polk	40	64	71	64	49
Sarasota	--	37	45	44	42

* Up to mid-1976
All levels shown in ug/m^3

SOURCE: EPA, 1978

TABLE 3-11

SO_2 DATA FOR SOUTH FORT MEADE SITE

	Jun-Aug 1979	Sept-Nov 1979	Dec 1979-Feb 1980	Jun 1979-Feb 1980
Number of Samples	1,691	1,964	2,013	5,668
1-Hour Concentration				
Maximum (ug/m^3)	377	233	259	377
Second (ug/m^3)	257	152	230	259
3-Hour Concentration				
Maximum (ug/m^3)	234	122	174	234
Second (ug/m^3)	212	120	151	212
24-Hour Concentration				
Maximum (ug/m^3)	40	28	90	90
Second (ug/m^3)	40	28	89	89
Arithmetic				
Mean (ug/m^3)	6.10	6.09	7.39	6.56
Standard Deviation (ug/m^3)	13.60	10.18	15.91	13.47

SOURCE: STUDY DATA

TABLE 3-12

COUNTY-WIDE AVERAGES FOR ANNUAL ARITHMETIC AVERAGE OF 24-HOUR SO_2 DATA

County	1972	1973	1974	1975	1975*
Charlotte	--	0	--	--	0
DeSota	--	0	0	5	1
Hillsborough	17	29	24	15	12
Manatee	11	10	5	3	2
Polk	--	21	42	10	7
Sarasota	--	3	1	1	1

-- No data
* Data reported to mid-1976

All levels shown in ug/m^3

SOURCE: EPA, 1978

TABLE 3-13

SOIL AND VEGETATIVE FLUORIDE DATA FOR SOUTH FORT MEADE MINE SITE

Sample	Date	Site Number	Fluoride (μg/g)
Pasture soil	8/7/79	1	30.2
Pasture soil	8/7/79	2	17.6
Pasture soil	8/7/79	3	7.1
Pasture soil	8/7/79	4	7.3
Grove soil	8/7/79	1G	9.9
Grove soil	8/7/79	2G	10.0
Pasture grass	8/3/79	1	14.6
Pasture grass	8/3/79	2	15.0
Pasture grass	8/3/79	3	11.7
Pasture grass	8/3/79	4	7.6
Citrus leaves	8/7/79	1G	4.8
Citrus leaves	8/7/79	2G	4.6
Pasture grass	10/22/79	1	10.6
Pasture grass	10/22/79	2	8.6
Pasture grass	10/22/79	3	5.3
Pasture grass	10/22/79	4	11.5
Citrus leaves	10/23/79	1G	8.1
Citrus leaves	10/23/79	3G	10.4
Pasture grass	01/31/80	1	15.6
Pasture grass	01/31/80	2	8.1
Pasture grass	01/31/80	3	17.3
Pasture grass	01/31/80	4	16.1
Citrus leaves	02/01/80	1G	10.0
Citrus leaves	02/01/80	2G	7.1
Pasture grass	04/25/80	1	11.1
Pasture grass	04/25/80	2	8.4
Pasture grass	04/25/80	3	39.6
Pasture grass	04/25/80	4	9.0
Citrus leaves	04/25/80	2G	8.5
Citrus leaves	04/25/80	3G	12.3

SOURCE: STUDY DATA

TABLE 3-14
NOISE LEVELS IDENTIFIED AS REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE

Effect	Level	Environments
Hearing Loss	$L_{eq(24)} \leq 70$ dBA	All
Interference and annoyance with outdoor activity	$L_{dn} \leq 55$ dBA	In residential areas, farms, and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq(24)} \leq 55$ dBA	Areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Interference and annoyance with indoor activity	$L_{dn} \leq 45$ dBA	Indoor residential areas.
	$L_{eq(24)} \leq 45$ dBA	Other areas with human activities, such as school, etc.

NOTES: L_{eq} = equivalent A-weighted sound level for 24-hour period.

L_{dn} = equivalent day-night A-weighted sound level.

SOURCE: EPA, 1974

TABLE 3-15
COMMUNITY REACTION TOWARDS AN OUTDOOR DAY/NIGHT SOUND LEVEL OF 55 dBA

Type of Effect	Magnitude of Effect
Speech	
Indoors	100 percent intelligibility (average) with a 5 dBA margin of safety.
Outdoors	100 percent intelligibility (average) at 0.35 meters.
	99 percent intelligibility (average) at 1.0 meter.
	95 percent intelligibility (average) at 3.5 meters.
Average Community Reaction	None evident; 7 dBA below level of significant "complaints and threats of legal action" and at least 16 dBA below "vigorous action" (attitudes and other non-level related factors may affect this result).
Complaints	1 percent dependent on attitude and other non-level related factors.
Annoyance	17 percent dependent on attitude and other non-level related factors.
Attitudes Towards Area	Noise essentially the least important of various factors.

SOURCE: EPA, 1974

TABLE 3-16

DESCRIPTION OF MONITORING LOCATIONS

Station Number	Description
1	Approximately 600 feet south of the end of the southernmost curve in Mt. Pisgah Road. Microphone was even with first row of orange trees approximately 75 feet from the edge of the pavement.
2*	Even with first row of orange trees on the south side of Mt. Pisgah Baptist Church; approximately 150 feet from the roadway.
3	Northeast corner of the intersection of Mt. Pisgah Road and County Line Road. Approximately 50 feet and 100 feet from the respective roadways.
4	Approximately 200 feet north of County Line Road on Manley Road.
5	3/4 mile south of Keller Road on gravel road in section 20.
6	2,000 feet north of Keller Road on paved road between sections 14 and 15. Microphone was approximately 10 feet from the pavement, adjacent to barbed wire fence.

NOTE: Stations 1 and 2 were effectively surrounded by orange groves. Stations 3 and 5 were encompassed one-quarter by orange groves and three-quarters by open field, woods, or pasture. Stations 4 and 6 were surrounded by field and pasture on all sides.

*Monitoring during the evening of 4/13/80 was performed approximately 1,000 feet south of the church due to a meeting in progress at that time.

SOURCE: STUDY DATA

TABLE 3-17

SUMMARY OF NOISE SURVEY RESULTS

Site		Weekend				Weekday			
		Nighttime (2200-0700)	Daytime (0700-1900)	Evening (1900-2200)	L_{dn}	Nighttime (2200-0700)	Daytime (0700-1900)	Evening (1900-2200)	L_{dn}
1	L_{10}	49	49	43		49	40	41	
	L_{50}	49	47	41		49	37	40	
	L_{90}	47	43	41		47	36	39	
	L_{eq}	49	48	41		49	38	40	
					55				55
2	L_{10}	47	47	47		49	39	43	
	L_{50}	47	41	45		47	37	41	
	L_{90}	45	35	43		45	35	39	
	L_{eq}	47	44	45		47	37	41	
					53				53
3	L_{10}	47	49	49		49	41	47	
	L_{50}	45	43	48		47	39	43	
	L_{90}	45	41	47		47	37	38	
	L_{eq}	45	44	48		47	39	44	
					48				53
4	L_{10}	43	53	41		45	47	49	
	L_{50}	41	51	39		41	43	49	
	L_{90}	41	49	39		41	41	45	
	L_{eq}	41	51	39		41	44	49	
					50				48
5	L_{10}	39	51	41		49	39	35	
	L_{50}	39	49	41		47	37	35	
	L_{90}	39	47	39		45	35	33	
	L_{eq}	39	49	41		47	37	35	
					49				53
6	L_{10}	45	51	49		49	39	38	
	L_{50}	45	49	47		47	35	35	
	L_{90}	45	46	47		45	33	33	
	L_{eq}	45	50	47		47	36	35	
					52				53

SOURCE: STUDY DATA

4.0 GEOLOGY AND SOILS

4.1 THE AFFECTED ENVIRONMENT

4.1.1 GEOMORPHOLOGY

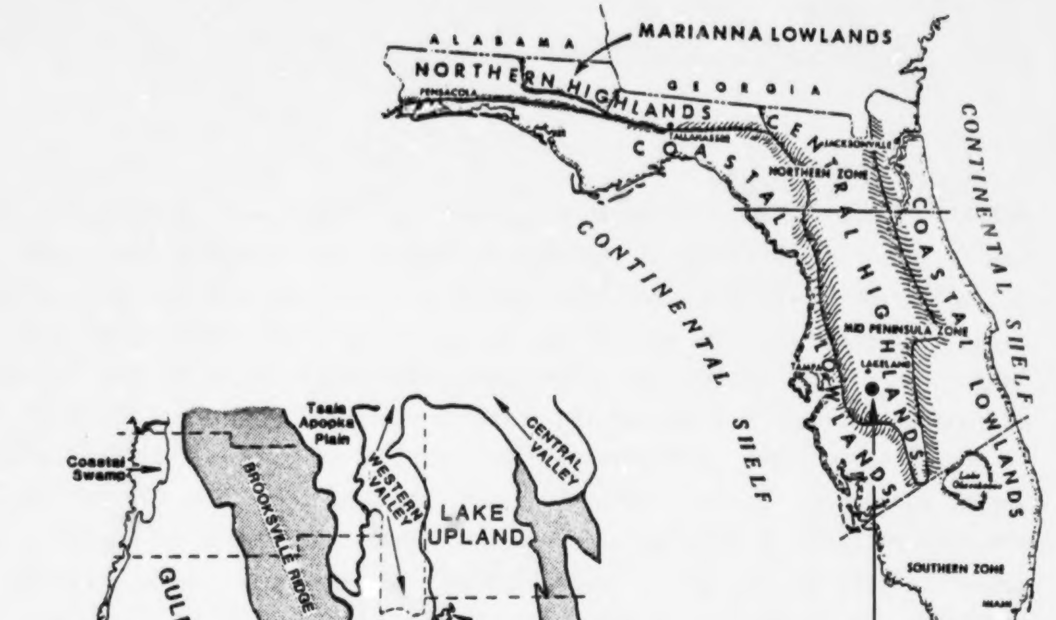
Mobil's proposed South Fort Meade Mine, shown on Figure 4-A, is located in the Central Highlands division of thre Mid-Peninsular Physiographic Zone as described by White (1970). The Central Highlands are characterized by localized areas of high ground such as the Lake Wales, Brooksville, Winter Haven and Lake Henry Ridges. These high, elongated, subparallel ridges follow the trend of residual coastal features of the Atlantic coast and rise above broad uplands of considerably lower elevation and less relief such as the Polk, Lake, Sumter and Marion Uplands. Large lowlands, the Central and Western Valleys, are also enclosed in the Central Highlands. Both the uplands and lowlands appear to have been eroded to their present elevations from a once existing highland. The topography of the proposed mine site is shown in Figure 4-B.

The Polk Upland, where the proposed mine is located, is an approximately square area bounded on the east by the higher ground of the Lake Wales Ridge (Figure 4-A). Lower ground surrounds the upland on two sides: the Desoto Plain to the south and the Gulf Coastal Lowlands to the west. The Western Valley and Lake Upland border the upland on the north.

The ground-surface elevation of the upland generally ranges from 100 to 130 feet above mean sea level. Except for the Winter Haven, Lakeland and Lake Henry Ridges which rise from its surface in the northeastern part, the Polk Upland is a broad, slightly dissected area of low topographic relief.

FIGURE 4-A

LOCATION OF SITE WITHIN CENTRAL HIGHLANDS AND POLK UPLAND

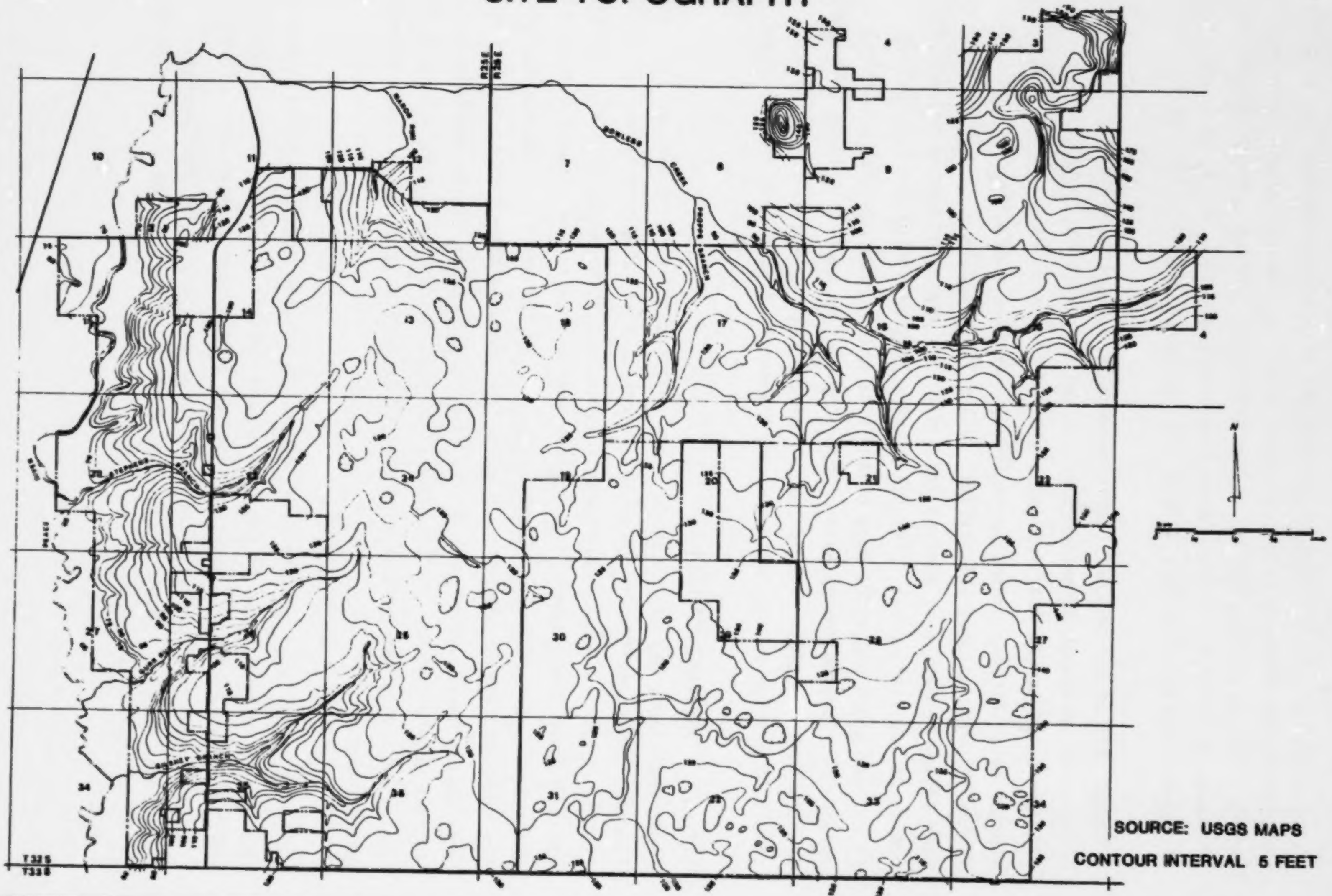


SOURCE: PURI & VERNON, 1964

SOURCE: White, 1970

FIGURE 4-B

SITE TOPOGRAPHY



SOURCE: USGS MAPS

CONTOUR INTERVAL 5 FEET

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best available copy.

The elevation of the Polk Upland corresponds to a marine terrace formed during the Pleistocene Epoch described by Cooke (1945) as the Sunderland Terrace. McNeil (1950) also described it as the Okefenokee Terrace. An escarpment at an elevation of 75 to 80 feet, most likely formed during the Wicomico sea level stand, separates the Polk Upland from the Desoto Plain to the south.

Although this upland and many other geomorphic divisions in Florida correspond to terraces, evidence established by Alt and Brooks (1965) suggests that terrain above 100 to 170 feet represent older deposits of Pliocene and upper Miocene age. Altschuler and Young (1960) show that surficial sands of the central Florida uplands are residual weathering products of the underlying Bone Valley Formation of Miocene age and do not represent marine terrace deposits of the Pleistocene. The siliclastic composition of the Bone Valley Formation, which underlies most of the Polk Upland, has contributed to the absence of a predominantly karst topography that is generally found throughout Florida (White, 1970). The topography of the Polk Upland is primarily the result of erosion by the surface streams whose headwaters are in the upland.

4.1.2 SOLUTION FEATURES

Karst topography has developed in large portions of northern and central Florida. An elongate zone of sinkholes breaches the Hawthorn Formation or younger surficial Miocene sediments (Cederstrom, 1979 and Stringfield, 1966). This sinkhole zone penetrates the upper geologic units and extends from north central Florida to the south central portion of the state, corresponding to the numerous Central Highlands ridges. The proposed mine site is located approximately twelve miles west of the closest occurrence of the sinkhole zone in Polk County. Mine site topography (as well as most of the Polk Upland) is due primarily to the erosional effects of surface waters rather than sinkhole development.

Solution activity in eastern Polk County, as well as most of the Polk Upland, appears to be restricted by two significant factors: a thick sediment cover overlying susceptible limestone units, and a consistently high water level. The sediment cover overlying the solution-susceptible Tampa and Suwannee Limestones attains a maximum thickness of some 50 feet in the vicinity of the proposed mine, thereby minimizing the possibility of the development of sinkholes. Localized solution channel development is further limited as the overburden materials are primarily siliclastic and are, therefore, predominantly solution-resistant (White, 1970). The relatively high and stable water level conditions in the local aquifer systems further serve to limit the potential for the development of solution features.

4.1.3 STRATIGRAPHY

During the well-drilling program, geologic formations ranging in age from Eocene to Recent were penetrated. Beginning with the oldest the formations are as follows: the Lake City Limestone, Avon Park Limestone, and the Ocala Group of Eocene age; the Suwannee Limestone of Oligocene age; the Tampa Formation and Hawthorn Formation of Miocene age; and undifferentiated clastics ranging in age from middle Miocene to Recent. A stratigraphic section of the proposed mine site is presented in Figure 4-C. Two geologic cross sections (A-A' and B-B') were developed from information associated with the well drilling and are shown in Figure 4-D Figures 4-E and 4-F display the geologic cross sections of the formations encountered for lines A-A' and B-B'.

A discussion of both the regional and site characteristics of the individual formations is given in the following sections. A literature review and an evaluation of both the geologic and geophysical logs were used to describe and delineate the formations.

4.1.3.1 Eocene Series

4.1.3.1.1 Lake City Limestone

In Polk County, the Lake City Limestone is a white to creamy, moderately soft to hard, chalky limestone approximately 420 feet in thickness. Secondary chert nodules occur in the upper part of the limestone, and dolomitized zones appear to follow bedding planes in the lower part of the formation. Lithologic continuity into the overlying Avon Park Limestone suggests that the contact is transitional (Stewart, 1966).

Data collected during the well-drilling program indicate that the top of the Lake City Limestone consists of a light tan, moderately indurated, dolomitic

FIGURE 4-C

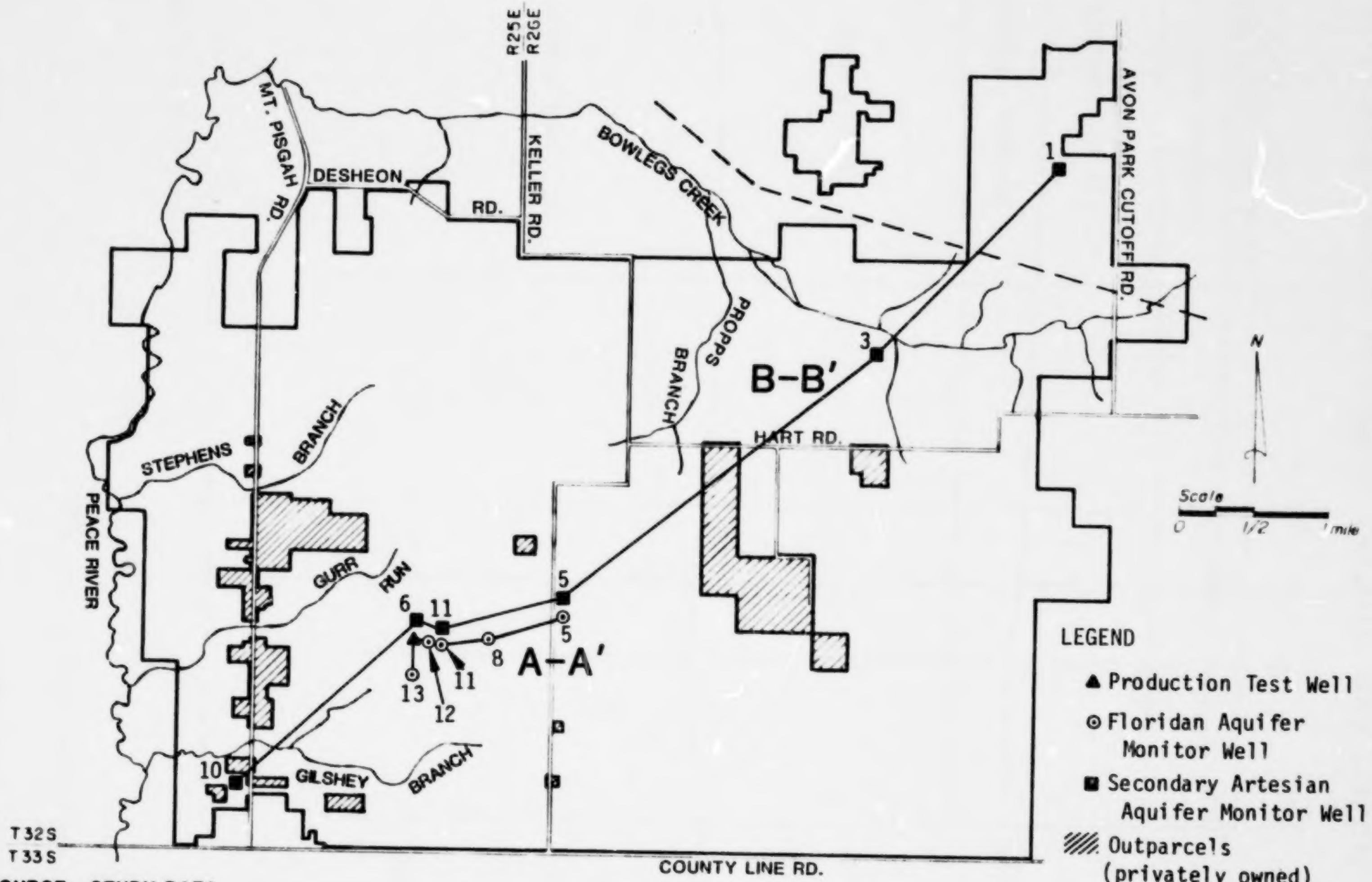
STRATIGRAPHIC SECTION OF THE PROPOSED MINE SITE

SYSTEM	SERIES	STRATIGRAPHIC UNIT		APPROXIMATE THICKNESS (FEET)	AVERAGE DEPTH IN FEET BELOW LAND SURFACE
QUATERNARY and TERTIARY	RECENT, PLEISTOCENE, PLIOCENE and MIOCENE	UNDIFFERENTIATED CLASTICS		45	45
TERTIARY	MIOCENE	HAWTHORN FORMATION		80	125
		TAMPA FORMATION	LIMESTONE UNIT	105	
			SAND & CLAY UNIT	70	300
	OLIGOCENE	SUWANNEE LIMESTONE		90	390
	EOCENE	OCALA GROUP	CRYSTAL RIVER FORMATION	340	
			WILLISTON FORMATION		
			INGLIS FORMATION		730
		AVON PARK LIMESTONE	LIMESTONE UNIT	275	
			DOLOMITE UNIT	160	
			LIMESTONE UNIT	240	1405
		LAKE CITY LIMESTONE			

SOURCE: STUDY DATA

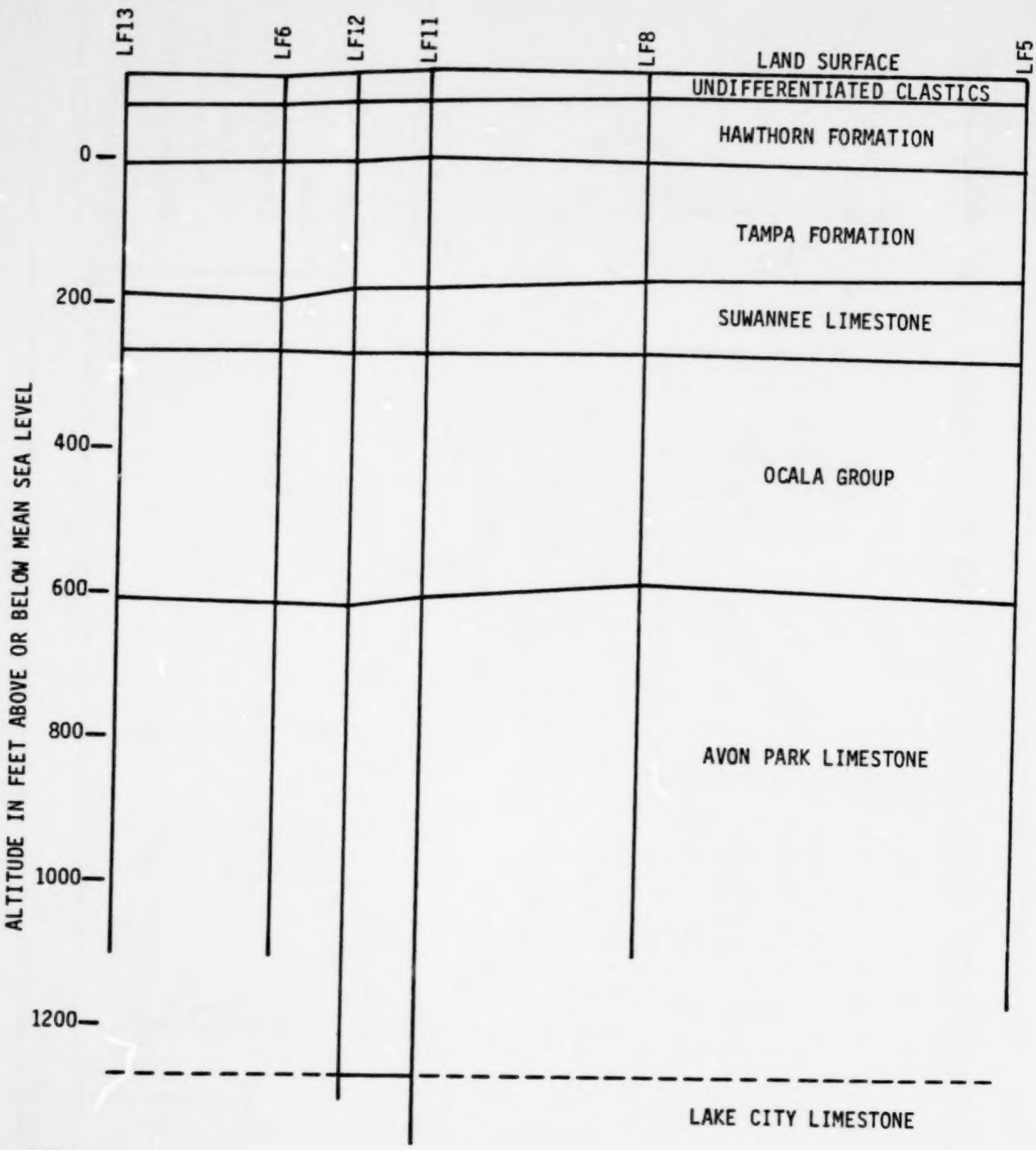
FIGURE 4-D

LOCATION OF GEOLOGIC CROSS SECTIONS A-A′ AND B-B′



SOURCE: STUDY DATA

GEOLOGIC CROSS SECTION ALONG LINE A-A'

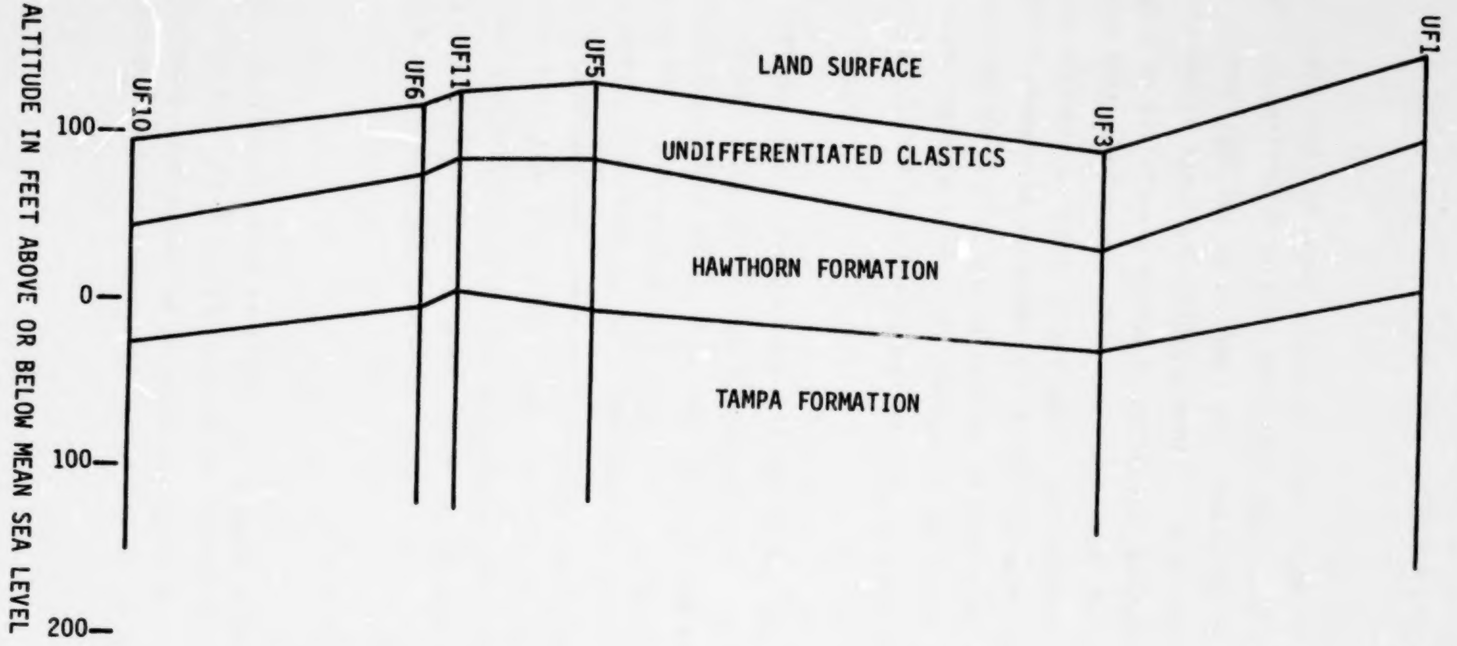


Horizontal scale = 1" = 1000'

SOURCE: STUDY DATA

FIGURE 4-F

GEOLOGIC CROSS SECTION ALONG LINE B-B′



Horizontal scale = 1" = 5000'

SOURCE: STUDY DATA

limestone interbedded with evaporites. The occurrence of evaporites in the two deepest wells drilled on the property defined the top of the Lake City Limestone at a depth of approximately 1,400 feet.

4.1.3.1.2 Avon Park Limestone

The Avon Park Limestone in Polk County is a dark brown to cream, very hard to soft, granular to chalky to finely crystaline, highly fossiliferous limestone, approximately 700 feet in thickness. The upper 80 to 135 feet consist of a hard, fractured dolomitized zone. Thinner, highly-fractured dolomitized zones occur throughout the formation, appearing as coarse gravel-like or honeycomb zones. The permeability of these areas and of cavernous zones that exist is very high, whereas the permeability of the chalky zones is moderate to low. The visible porosity and permeability of the formation as a whole is very high. A marker bed of chert ranging between 10 and 15 feet in thickness is generally found at the top of the formation. Evaporite minerals occur in considerably less quantity than in the underlying Lake City Formation (Stewart, 1966).

At the proposed mine, the top of the Avon Park Limestone was encountered at a depth averaging 730 feet. The entire thickness of the formation was penetrated by two wells and was found to consist of three lithologic units: a limestone unit, a dolomite unit, and a basal limestone unit. The upper limestone unit is approximately 275 feet thick and consists of a yellowish brown, hard, granular to crystalline, dolomitic limestone interbedded with soft, chalky limestone and traces of sandy clay. The middle unit is a yellowish brown to grayish brown, hard, crystalline dolomite approximately 160 feet in thickness. The basal unit of the Avon Park Limestone consists of a yellowish brown to tan, moderately hard to soft, dolomitic limestone approximately 240 feet in thickness.

4.1.3.1.3 Ocala Group

In Polk County, the Ocala Group is divided into three formations: the Inglis Formation, the Williston Formation, and the Crystal River Formation. At the mine site, the top of the group was found at an approximate depth of 390 feet with an average thickness of 340 feet. The three formations are described below.

Inglis Formation: This formation consists of a white to cream to dark brown, generally hard, granular, partially to highly dolomitized, highly fossiliferous limestone with chalky zones. The lower section of the formation has a high to moderate visible porosity due to the removal of the calcite cement and matrix. Cavernous areas exist throughout the formation. The formation unconformably (not succeeding in an immediate order of age) overlies the Avon Park Limestone and ranges in thickness from 35 feet in central Polk County to approximately 95 feet in the southern part of the county. The Inglis Formation underlies all of Polk County except in the northeastern part. In the extreme northeastern part of the county, along the crest of a structural high, it is the uppermost limestone due to erosion of the overlying beds (Stewart, 1966).

Williston Formation: Conformably (succeeding in an immediate order of age and in parallel position) overlying the Inglis Formation is the Williston Formation consisting of a white to cream, generally soft, coarse, limestone with coquina of foraminifera contained in a chalky, calcite matrix. Except for the lower 5 to 15 feet which have been hardened by dolomitization, the formation is generally less dolomitized than the underlying formations.

In most of Polk County, the thickness ranges from 10 to 100 feet, and averages about 30 feet. In the northeastern part of the county, the formation is missing, having been removed by erosion. The contact between the Williston Formation and the underlying Inglis Formation is marked by a distinct lithologic change. The upper conformable contact with the overlying Crystal River Formation, however, is very transitional (Stewart, 1966).

Crystal River Formation: The Crystal River Formation is a white, gray, cream or tan, generally very soft, coarse, granular, limestone containing a very large number of foraminifera in a chalky carbonate matrix. The visible porosity and permeability are low to moderate due to this very soft, chalky matrix (Stewart, 1966). Erosion has entirely removed the formation in parts of northeastern Polk County. In the north-central part of the county, the Crystal River Formation is approximately 30 feet thick and increases to greater than 150 feet in the southern part. It lies conformably upon the

Williston Formation and is unconformably overlain by the Suwannee Limestone of Oligocene age (Vernon, 1951).

4.1.3.2 Oligocene Series - Suwannee Limestone

The Suwannee Limestone is a white to tan, generally soft, granular detrital, usually pure limestone containing abundant bryozoa, small mollusca, and large echinoids. Chert lenses ranging from a few inches to a few feet thick are often found replacing the limestone near the top and middle parts of the formation. The lower portion is generally chalky and less granular than the upper part. The thickness of this formation ranges from 80 to 120 feet in the central and southern parts of Polk County and is either very thin or absent in the northeastern part due to both depositional and erosional thinning (Stewart, 1966).

At the project site, the Suwannee Limestone is a yellowish brown, soft, granular fossiliferous limestone containing fragments of chert, and traces of sandy clay. It was first encountered at a depth of approximately 300 feet and has an average thickness of 90 feet.

4.1.3.3 Miocene Series

4.1.3.3.1 Tampa Formation

The Tampa Formation in Polk County is a clay sequence generally composed of a bluish to greenish gray, calcareous, locally phosphatic, sandy, shaley clay that contains lenses, fragments, and thin beds of white to gray sandy limestone. Thickness ranges from approximately 10 feet to possibly greater than 80 feet. The Tampa Formation in Hillsborough County consists of a limestone unit from approximately 80 to 110 feet thick and an overlying sequence of interbedded bluish to greenish gray, sandy clays, sandy limestones, and calcareous sands (Stewart, 1966).

At the proposed mine site, two lithologic units compose the Tampa Formation. The upper unit is a pale, yellowish brown to light gray, sandy, clayey, often partially dolomitic limestone interlayered with phosphatic sands. The top of the limestone unit was encountered at an average depth of 125 feet and has an average thickness of 105 feet. The lower unit consists of a light olive gray to greenish gray, sandy, calcerous clay containing traces of phosphate. The clay unit has an average thickness of 70 feet.

4.1.3.3.2 Hawthorn Formation

The Hawthorn Formation in Polk County is a light cream to yellow tan, very hard to soft, very sandy, clayey, phosphatic limestone, interbedded with soft, sandy, phosphatic, usually gray to dark bluish or greenish gray clay. The formation ranges in thickness from approximately 20 feet to as much as 160 feet in some parts of the county. Although the limestone beds are extensive, they are not easily distinguishable. This formation unconformably overlies the Tampa Formation and unconformably underlies the undifferentiated clastics ranging from middle Miocene to Recent (Stewart, 1966).

The Hawthorn Formation was first encountered at the proposed mine site, at an average depth of 40 feet and has an average thickness of 80 feet. The composition consists of a yellowish gray to light gray to reddish brown calcareous, sandy clay interbedded with thin beds of limestone and phosphate fragments. The clay zones of the Hawthorn Formation, together with overlying clays, function as an aquiclude separating the surficial aquifer from the Upper Floridan Aquifer.

4.1.3.4 Undifferentiated Clastics

Clastics ranging in age from middle Miocene to Recent overlie the Hawthorn Formation in Polk County. A lower unit, generally considered to be part of the Bone Valley Formation, consists of sandy clays containing pebble phosphate overlain by sands and sandy clays leached of their original phosphate. An upper unit is composed of white to reddish, clayey, partially indurated quartz sands. The present soils have developed on unconsolidated quartz sands which entirely blanket the county (Stewart, 1966).

At the proposed mine site, the lower unit of the undifferentiated clastics is composed of a yellowish gray to greenish gray, sandy clay interlayered with reddish brown to black phosphate pebbles. The mineable phosphate is contained in this lower unit. The upper unit consists of a pale orange to light gray, clayey sand interlayered with weathered phosphate fragments. The thickness of the clastics varies according to the thickness of the individual units, but generally has a combined thickness of approximately 40 feet. The lower unit of the undifferentiated clastics, in combination with the underlying Hawthorn clays, separate the surficial aquifer from the Floridan aquifer below.

4.1.4 PROPOSED MINE SITE GEOLOGY

The ore bearing zones, contained in the lower section of the undifferentiated clastics, consist of a sandy clay matrix interlayered with phosphate pebbles. This lower section averages 25 feet thick and is generally overlain by some 20 feet of sandy overburden (Figure 4-G). The typical mine excavation will extend approximately 45 feet below present ground surface, terminating at the clay bed overlying the Hawthorn Formation.

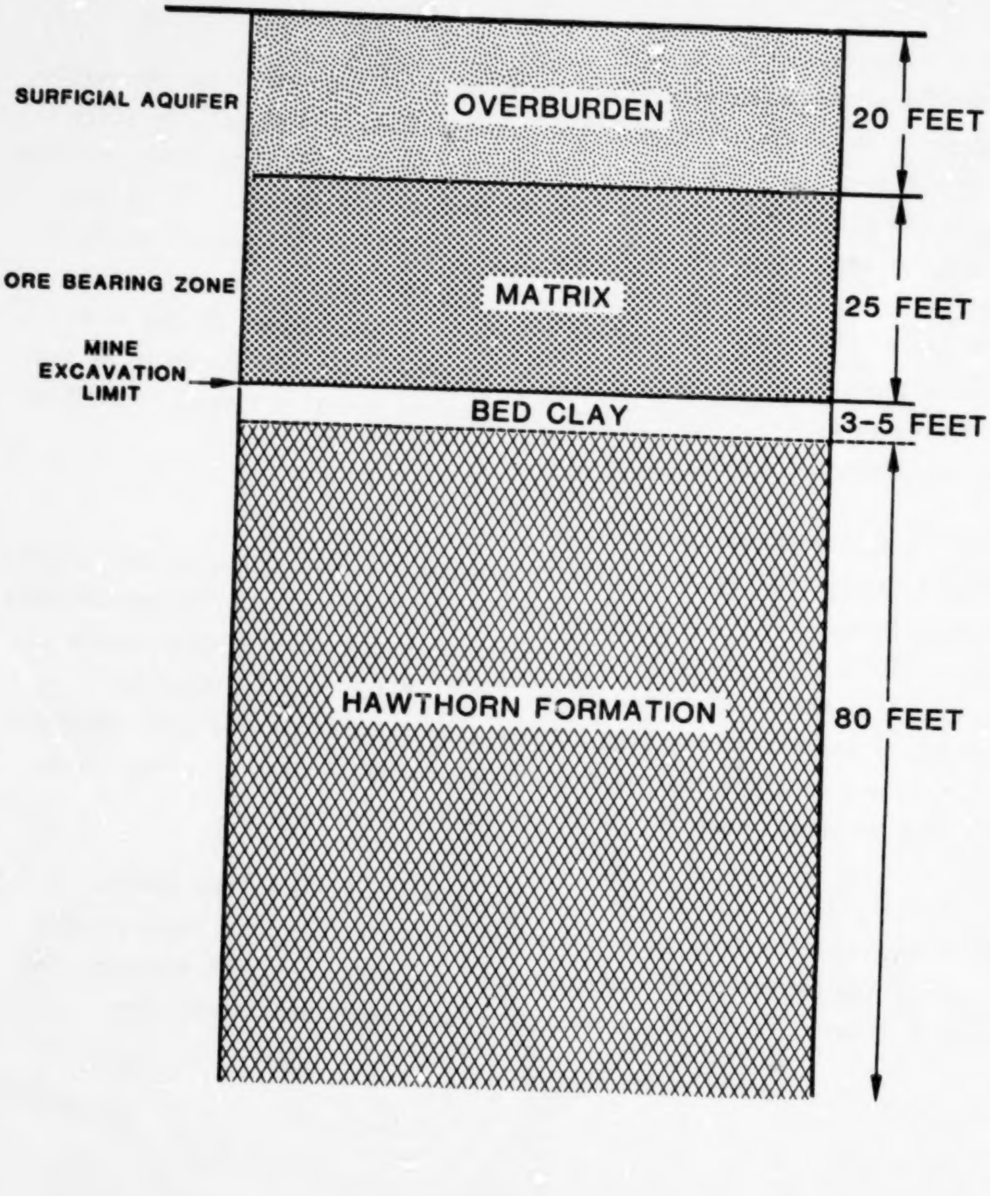
The potential for subsidence due to mining-induced solution activity in the area is considered unlikely due to the thickness of clastic units overlying solution-susceptible units and the relatively stable and uniformly high water level elevations. Solution or collapse features are not known to exist near the proposed site. The primary factor for the development of surface features at the site has been described as surface water flow (White, 1970). The significant alteration of groundwater levels could conceivably induce solution activity; however, potentiometric levels are presently stable at the site.

4.1.5 STRUCTURE

The predominant structural feature affecting the area of interest is the Ocala Arch. The long axis of the regional anticline (geologic fold) follows a northwest-southeast line beginning in Dixie County and extending southward into northeastern Polk County. Movements that produced the Ocala Arch had their beginnings during the Eocene Age, prior to the description of the rocks of the Ocala Group (Stewart, 1966). As a result of the uplift, the rocks in Polk County dip at low angles and thicken toward the southeast, south, and southwest end of the Ocala Arch. Fractures and faults associated with the formation of the arch are known to exist within the limestones of the region.

FIGURE 4-G

GEOLOGIC SECTION AT THE PROPOSED MINE



SOURCE: STUDY DATA

4.1.6 SEISMICITY

Historically, the State of Florida has been characterized by very low seismic activity. Few significant events occurring within the state have been recorded in modern time. The maximum intensity of events known to have occurred within Florida were recorded at Modified Mercalli (MM) intensity V (Stover et al., 1979). It is unlikely that stronger events will occur or strong intensities will be observed within Florida's boundaries.

4.1.7 SOILS

The Soil Conservation Service (SCS) has been compiling extensive information on the soils in Central Florida and was commissioned to conduct the soils survey for the proposed South Fort Meade Mine site. The SCS determined that the soils on the site are typical of those throughout the region. In addition, core samples were collected at six locations on the site in order to characterize the near-surface soils and project the engineering and agronomic properties of the reclaimed surface materials. The analyses of the core samples are presented in Table 4-1. The surface soils were found to be generally very sandy (94.7 to 98.7 percent), acidic (pH of 4.2 to 6.4) and low in plant available nutrients.

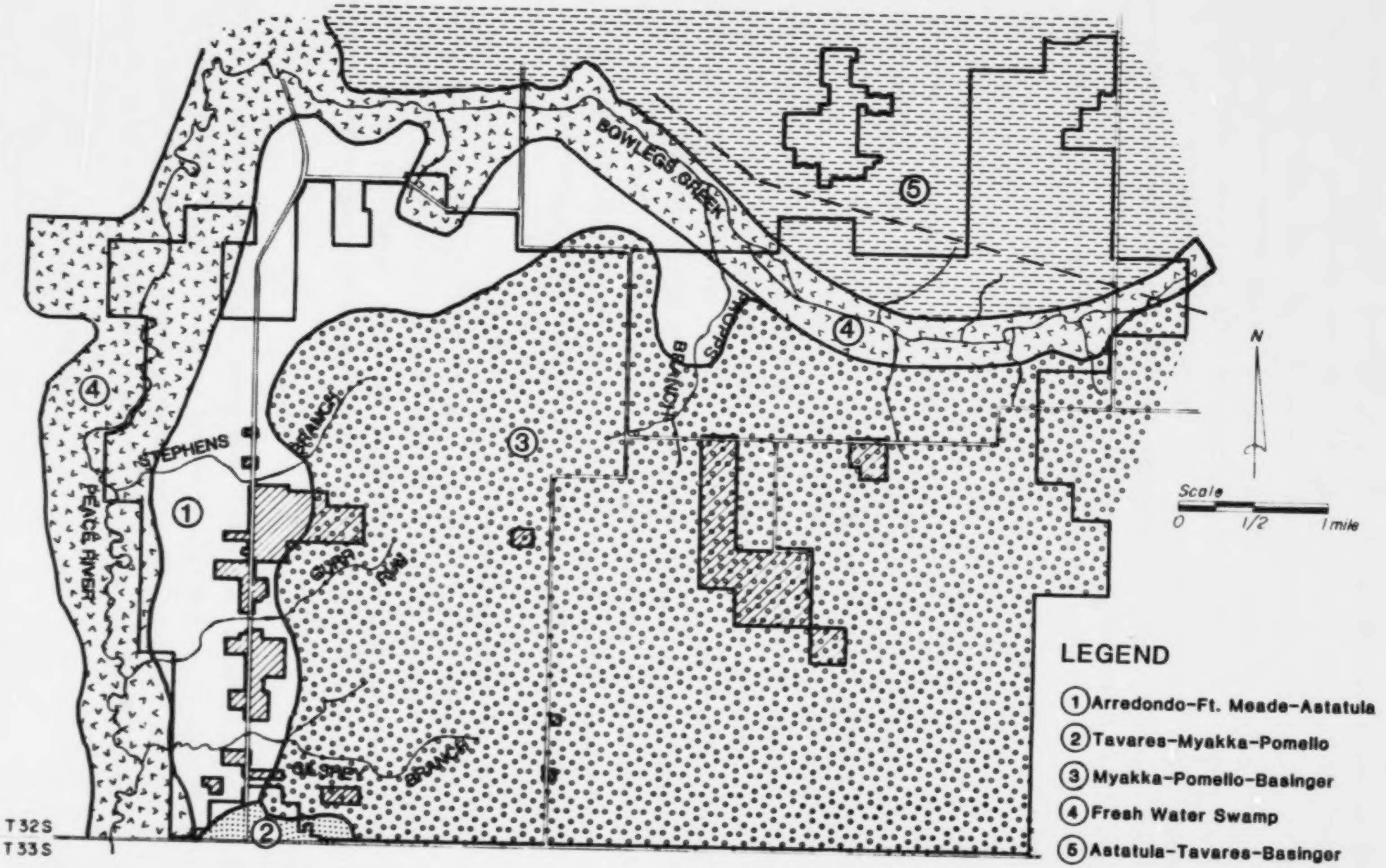
4.1.7.1 Soil Associations

A general county-wide study by the SCS grouped the soils covering the proposed mine site into the following five general soil associations: Arrendondo-Fort Meade-Astatula (covering 13 percent of the site), Tavares-Myakka-Pomello (covering less than one percent of the site), Myakka-Pomello-Basinger (covering 67 percent of the site), Freshwater Swamp (covering nine percent of the site), and Astatula-Tavares-Basinger (covering 11 percent of the site). The extent of these associations is shown in Figure 4-H.

Approximately 76 percent of the project site is covered by the Myakka-Pomello-Basinger and Freshwater Swamp soil associations which have severe foundation limitations for construction of buildings or light industry. The remaining areas have slight to moderate foundation limitations. The

FIGURE 4-H

SOIL ASSOCIATION MAP



SOURCE: SOIL CONSERVATION SERVICE

Arrendondo-Fort Meade-Astatula and the Myakka-Pomello-Basinger soil associations comprise 80 percent of the site and land within these associations has a high potential for improved pasture. The land within the Arrendondo-Fort Meade-Astatula and the Astatula-Tavares-Basinger soil associations has a high potential for citrus production. With the exception of the Freshwater Swamp soil association, most of the land on the site is a sandy material which has a high percolation rate and is a poor topsoil. The Arrendondo-Fort Meade-Astatula, Tavares-Myakka-Pomello, and Astatula-Tavares-Basinger soil associations are droughty areas while the Myakka-Pomello-Basinger and Freshwater Swamp soil associations are characterized by damp to wet soil conditions.

4.1.7.2 Soil Series

The SCS identified 34 soil series within the designated tract (Figure 4-I) during the 1979 study. Appendix B includes descriptions of these soils. Total acreage and relative percentages of each specific soil series are tabulated in Table 4-2. Dominant soil series found on the site are Pomona Fine Sand (3,327 acres), Myakka Fine Sand (3,144 acres), Ona Fine Sand (1,503 acres) and Zolfo Fine Sand (1,732 acres). Collectively, the dominant soil series account for 9,706 acres of the 17,355 acres which were mapped (acreage includes outparcels within the proposed mine site). The table also identifies common topographical features which may be associated with the soil series. These classifications indicate the typical drainage and/or topographic features such as upland, flatwoods, depressional or floodplain areas.

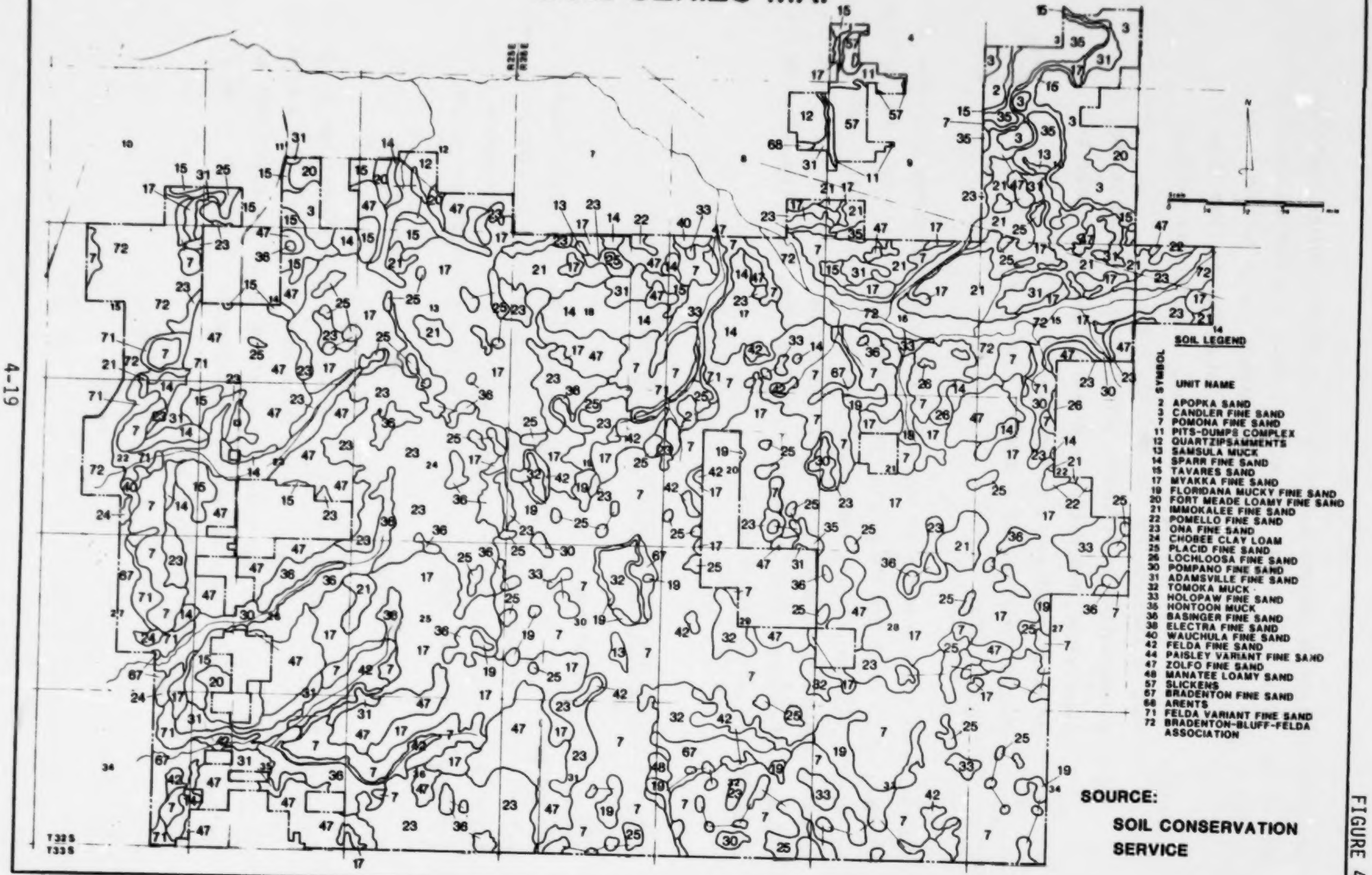
4.1.7.3 Unique Agricultural Lands

The SCS has prepared definitions of prime agricultural soils and unique citrus areas in an effort to assure consideration of agricultural resources. There are no designated prime agricultural soils on the proposed mine site because the soils on the site lack the fertility, organic composition and other properties required for this category.

Unique farmland is land other than prime farmland that is used for the production of specific high value food and fiber crops. It has the special combination of soil quality, location, growing season and moisture supply needed to economically produce sustained high quality and/or high yields of a specific

FIGURE 4-I

SOIL SERIES MAP



SOIL LEGEND

SYMBOL	UNIT NAME
2	APOPKA SAND
3	CANDLER FINE SAND
7	POMONA FINE SAND
11	PITS-DUMPS COMPLEX
12	QUARTZIPSAMMENTS
13	SAMSULA MUCK
14	SPARR FINE SAND
15	TAVARES SAND
17	MYAKKA FINE SAND
19	FLORIDANA MUCKY FINE SAND
20	FORT MEADE LOAMY FINE SAND
21	IMMOKALEE FINE SAND
22	POMELLO FINE SAND
23	ONA FINE SAND
24	CHOBEE CLAY LOAM
25	PLACID FINE SAND
26	LOCHLOOSA FINE SAND
30	POMPANO FINE SAND
31	ADAMSVILLE FINE SAND
32	TOMOKA MUCK
33	HOLOPAW FINE SAND
35	HONTOON MUCK
36	BASINGER FINE SAND
38	ELECTRA FINE SAND
40	WAUCHULA FINE SAND
42	FELDA FINE SAND
44	PAISLEY VARIANT FINE SAND
47	ZOLFO FINE SAND
48	MANATEE LOAMY SAND
57	SLICKENS
67	BRADENTON FINE SAND
68	ARENTS
71	FELDA VARIANT FINE SAND
72	BRADENTON-BLUFF-FELDA ASSOCIATION

SOURCE:

SOIL CONSERVATION SERVICE

crop when treated and managed according to acceptable farming methods. Examples of such crops are citrus, tree nuts, olives, cranberries, fruit and vegetables. Specific criteria for unique farmlands are as follows:

(1) cultivation of a specific high value food or fiber crop
(2) a moisture supply (precipitation, irrigation or stored) that is adequate for the specific crop
(3) a combination of favorable soil quality, growing season, temperature, humidity, air drainage, elevation, aspect, or other conditions, such as nearness to market, that favors the growth of a specific food or fiber crop (USDA, 1978).

Some areas of the proposed mine site are among those designated as unique citrus lands. These are the citrus groves identified on Figure 4-J as defined by the SCS. The majority of the unique citrus areas are located on privately owned outparcels or adjacent properties to the proposed mine site. There are 566 acres of orange groves on the proposed mine site, of which, 446 acres are classified as unique citrus lands.

4.2 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

4.2.1 THE NO ACTION ALTERNATIVE

The geology and soils resources on the proposed mine site would remain basically in their present state if the no action alternative is taken. The geologic formations would not be disturbed and the soils would continue to support pasture grasses, vegetative cover and limited agricultural crops.

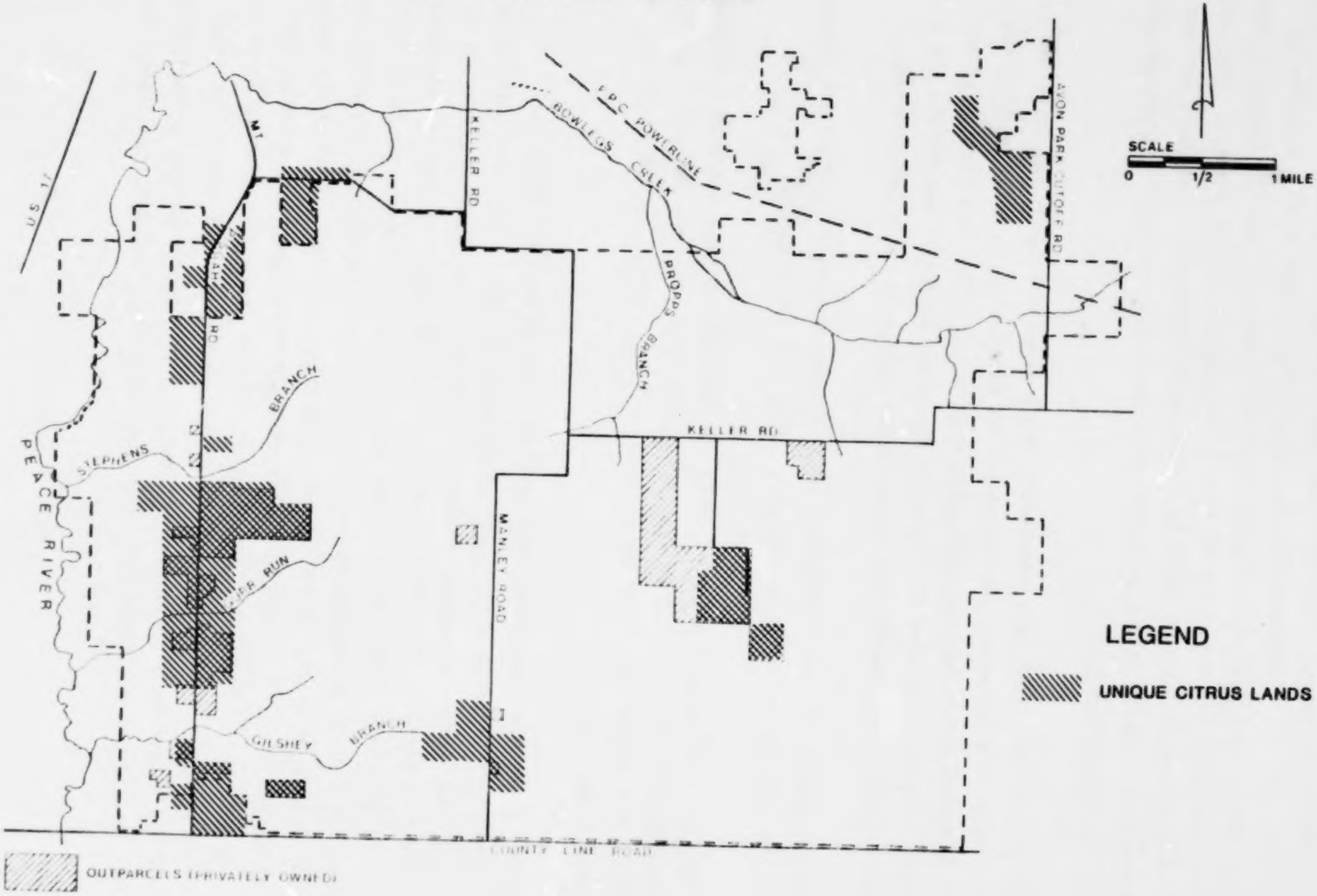
4.2.2 THE ACTION ALTERNATIVES INCLUDING THE PROPOSED ACTION

4.2.2.1 Mining Method Alternatives (See description DEIS 2.2)

Dragline (Mobil's Proposed Action): The proposed mining operation would disturb 15,194 acres (93 percent) of the South Fort Meade site. Included in this area are 566 acres of orange groves of which 446 acres are classified as unique citrus lands. This represents approximately 0.3 percent of the citrus producing land in Polk County, Florida.

FIGURE 4-J

UNIQUE CITRUS LANDS



SOURCE: SOIL CONSERVATION SERVICE

Mining the site would involve removing the overburden in order to expose the ore bearing deposit consisting of the lower section of the undifferentiated clastics zone. The phosphate matrix, averaging 25 feet thick, would be removed to the clay bed overlying the Hawthorn Formation, and the bottom of the mine excavation would average 45 feet below present ground surface. The void created by matrix removal would be filled with overburden, sand tailings and clay wastes. Soils in the disturbed area would undergo major disruption and loss of identification.

The practice of leach zone management would allow the leach zone material to be placed in a pocket at the bottom of the mined area (pocket toe spoiling), to be subsequently covered with overburden spoil. This would minimize the impact of redistribution of naturally occurring radionuclides during the mining operation and reduce surface radiation levels on reclaimed landforms.

Bucket Wheel: Mining with bucket wheel excavators would have similar impacts on the geology and soils resources as those for the dragline.

Dredge: Leach zone management could not be achieved with the dredge method of mining; therefore, radiation levels would be higher in the reclaimed landforms with this method than with the proposed action. Other impacts would be similar to the dragline method.

4.2.2.2 Matrix Processing Alternatives (See description DEIS 2.4)

Conventional Beneficiation (Mobil's Proposed Action): The beneficiation process would remove phosphate product from waste clays and sand contained in the phosphate matrix. The waste clays would then be piped to storage impoundments for dewatering. Mobil reports that the mine site contains a total of 150 million tons of phosphate resource. With present technology, phosphate with a particle size smaller than 200 mesh cannot be recovered. Thus, the mine site contains 119 million tons of recoverable phosphate (particle size greater than 200 mesh) and 31 million tons of unrecoverable phosphate. Conventional processing proposed at the South Fort Meade site would extract about 77 million tons of the recoverable phosphate from the ore, with approximately 42 million tons of recoverable phosphate lost with the waste clays and sand tailings. This constitutes an efficiency of 65 percent in recovering the "recoverable" phosphate. Mobil is actively pursuing development of advanced process technology that would allow for recovery of phosphate smaller than 200 mesh. The phosphate contained in the waste clays could be reprocessed when such technology is developed.

Dry Separation: Dry separation involves processing the pulverized matrix through a fluidized air bed favoring separation of pebble phosphate and clay. Since the phosphatic ore at the proposed mine is primarily fine material, less than 48 percent of the recoverable phosphate (57 million tons) could be separated through this processing method. The dry waste clays with fines would be placed in mined areas eliminating the need for above-ground storage. If advanced phosphate recovery technology becomes feasible, remining and processing of the waste clays could be done in the future.

4.2.2.3 Waste Disposal Alternatives (See description DEIS 2.5)

Conventional Clay Settling Case (Mobil's Proposed Action): Approximately 50 percent (8,170 acres) of the mine site would be above-grade clay settling ponds with an average dam height of 38.7 feet. The increased loading on the Hawthorn Formation from the above-grade waste storage would average about 17 pounds per square inch (psi). The clay settling areas would contain 58 million tons of phosphate resource that could be remined should advanced recovery technology be developed. The 58 million tons of phosphate would be contained in a mixture with 74 million tons of clay. This 132 million tons of clay residue has a ratio of 0.44 tons of phosphate to one ton of clay. This is termed a concentration ratio and describes the phosphate to total residue relationship as a decimal fraction. Therefore, the smaller the decimal fraction, the greater is the amount of material that would have to be processed in order to obtain one ton of phosphate.

Sand/Clay Cap Case: The dam heights for the 7,580 acres of clay settling basins required for this alternative would average 36.7 feet above natural grade. This is two feet less than the average dike height for the conventional waste disposal case, resulting in an average loading to the Hawthorn Formation of about 16 psi. The addition of a sand/clay cap to the clay settling basins would slightly increase the future effort required to recover phosphate from the clay wastes. Mobil could either use earthmoving equipment to strip off the sand/clay cap, or could remine and process the cap together with the clay settling basins. In the latter case, the phosphate resource would be about 60 million tons and the concentration ratio would be 0.35.

Sand/Clay Mix Case: The sand/clay mix case would result in 3,352 acres of sand/clay mix impoundments and 4,827 acres of clay settling ponds above natural grade. The average dike height for the 8,179 acres of above-grade basins would be 35 feet. The increased loading to the Hawthorn Formation would average about 16 psi. Should advanced phosphate recovery technology become available, the sand/clay mix areas would be more difficult to reprocess because of the presence of the additional sand. Considering both the clay settling and sand/clay mix basins together, the concentration ratio would be approximately 0.26. Phosphate resources in the clay settling basins and sand/clay mix basins would be about 65 million tons.

Overburden Mix Case: Overburden sand would be used to supplement the sand tailings mixed with clay, resulting in a waste disposal method similar to sand/clay mix. The average dam height for 8,339 acres of above-grade settling basins would be 38 feet above natural grade. The increased loading to the Hawthorn Formation would average about 17 psi. Potential recovery of phosphate from waste clays would be more difficult with this case because of the large volume of sand/clay mix areas. The concentration ratio would be 0.16 for this case. Phosphate resources which would be contained in the sand/clay mix basins would be about 65 million tons.

4.2.2.4 Reclamation Alternatives (See description DEIS 2.6)

The proposed action and alternative reclamation plans consist of different combinations of nine different types of landforms. A brief description of these landforms and plant available nutrient analyses are presented in Table 4-3. More detailed discussions of the landforms are presented under the proposed action and each alternative.

Conventional Clay Settling Plan (Mobil's Proposed Action): The conventional plan provides for the reclamation of all the land disturbed by mining. Acreages of the land areas to be reclaimed are presented below, and characteristics of the reclaimed landforms are discussed in the following subsections.

Reclaimed Landform	Reclaimed Acreage
Sand Tailings Fill Areas with Overburden Cap	5,034
Above-Grade Clay Settling Areas (Uncapped)	6,681
Above-Grade Clay Settling Areas with Sand Cap	1,489
Below-Grade Clay Settling Areas	1,513
Miscellaneous Areas (including overburden fill areas)	477
Total	15,194

Sand Tailings Fill Areas with Overburden Cap: Sand tailings are composed almost entirely of sand-sized particles, resulting in a reclaimed landform with good structural stability and internal drainage properties. Sand tailings are low in plant available nutrients with the exception of calcium and phosphorus which are provided by the residual phosphate particles. In addition, sand tailings soils have low retention capacities for moisture and applied nutrients due to the virtual absence of clay. If left as the surface soil, these soils would have a low potential for agricultural productivity. Therefore, all sand tailings fill areas would be capped with overburden to an average depth of two feet in order to provide a reclaimed soil with favorable agronomic properties and to bring the reclaimed surface to approximately premining grade. The overburden soils used for cap material should equal the existing surface soils in terms of potential agricultural productivity. The 5,034 acres of sand tailings overburden cap area more closely approximates the premining soil conditions than any other reclaimed landform except for overburden fill.

Above-Grade Clay Settling Areas (Uncapped): The 6,681 acres of uncapped above-grade clay fill areas would have phosphatic clay both as the backfill material and the reclaimed surface soil. These areas would undergo a period of subsidence and the reclaimed soil would have poor structural stability. Without expensive adaptation such as the use of pilings, these areas would not be suited for structural development.

Phosphatic clays have some favorable agronomic properties according to University of Florida soil test recommendations. Site-sampled levels of calcium, magnesium and phosphorus are over ten times the levels considered to indicate high availability for these essential elements. Levels of available potassium are at or above the levels considered to indicate a high availability for this nutrient. Of the major fertilizer nutrients, only nitrogen is deficient in phosphatic clay soils. The dominance of clay gives excellent moisture and nutrient retention capabilities. However, this soil is difficult to cultivate and is subject to waterlogging during the wet season. Because of this, phosphatic clay soils are best suited to perennial forage crops which will tolerate periodic flooding and which require no cultivation after establishment.

Above-Grade Clay Settling Areas with Sand Cap: The 1,489 acres of capped clay settling areas would have a sand tailings cap averaging nine feet thick as the surface soil and clay as the subsurface fill. The sand cap would promote consolidation of the subsurface clay fill, enhancing the structural stability of this reclaimed landform. Sand tailings are agronomically inferior to phosphatic clay. Plant nutrient application requirements would be high and forage production would probably be limited primarily to the wet season. The reclaimed sand capped settling areas on the site would be best suited for use as improved pastures.

Below-Grade Clay Settling Areas: The 1,513 acres of below-grade clay filled areas are designed specifically for wetland reclamation. The clay backfill material would occupy the interspoil depressions and would be partially capped with overburden graded from adjacent spoils. Drainage outfalls and fill levels would be designed to provide areas of open water adjoined by seasonally flooded zones sloping up to graded spoil areas which would be inundated only at high water.

Miscellaneous Areas: These areas would include the overburden fill areas (308 acres), the former plant site (124 acres) and the water pool filled in with overburden (45 acres). These areas have soils with structural properties the same as those presently existing. The areas can support tree plantings or buildings.

Sand/Clay Cap Plan: This reclamation plan would modify the acreages associated with the various reclaimed landforms of the conventional case; however, the basic layout of basins and fill areas would be essentially the same. Acreages of the various types of reclaimed disposal areas for the sand/clay cap plan are presented below and further descriptions of the reclaimed landforms are discussed in the following subsections.

Reclaimed Landform	Reclaimed Acreage
Sand Tailings Fill Areas With Overburden Cap	5,079
Above-Grade Clay Settling Areas with Sand-Clay Mix (4:1) Cap	7,580
Above-Grade Clay Settling Areas with Overburden Cap	590
Below-Grade Clay Settling Area	1,513
Miscellaneous Areas	432
Total	15,194

Sand Tailings Fill Areas with Overburden Cap: Reclamation of the sand tailings fill areas with overburden cap would be similar to the proposed action except that an additional 45 acres of this type landform would be included with the sand/clay cap reclamation plan.

Above-Grade Clay Settling Areas with Sand/Clay Mix Cap: Above-grade clay settling areas with sand/clay cap would be used for 7,580 acres of the site, approximately 50 percent of the reclaimed area. The cap would be sand and clay mixed in a 4:1 ratio, resulting in a sandy loam soil (standard soil textural classification). Sand/clay mix soils are projected to consolidate more rapidly and have better load bearing capacity than clay soils. However, clay settling areas capped with sand/clay mix would still undergo a period of gradual subsidence. Consequently, clay settling areas capped with sand/clay mix would probably not be suited for structural development in the immediate future.

Sand/clay mix soils are expected to be good agricultural soils. In a 4:1 sand/clay mix, the clay component would contribute fertility, moisture holding capacity and nutrient retention properties to the mixture. The sand component would serve to alleviate the problems of tillage and poor permeability that are associated with clay alone. The best agricultural use of sand/clay soils would have to be determined by experimentation under field conditions, but improved pasture is a likely choice and the production of row crops such as vegetables should be feasible. The load characteristics of the 4:1 sand/clay mix should be sufficient to support the growth of mature trees.

Above-Grade Clay Settling Areas Capped with Overburden: Approximately 590 acres would be reclaimed as above-grade clay settling areas capped with overburden. The reclaimed landform characteristics of these areas would be good moisture and nutrient retention capabilities, poor structural stability, good nutrient availability and favorable agronomic properties such as tillage.

Below-Grade Clay Filled Areas: The 1,513 acres of below-grade clay settling areas would be designed specifically for wetland re-creation. As in the conventional clay settling case, the same acreage of reclaimed wetlands would replace the existing wetlands.

Miscellaneous Areas: These areas would include overburden fill areas (308 acres) and the former plant site (124 acres). These areas would have soils with structural properties the same as the existing soils and could support tree plantings or buildings.

Sand/Clay Mix Plan: This reclamation plan would modify the layout of the waste disposal areas as well as the acreages of the reclaimed landforms. The types of reclaimed landforms for the sand/clay mix plan are as follows:

Reclaimed Landform	Reclaimed Acreage
Sand Tailings Fill Areas with Overburden Cap	3,020
Above-Grade Sand/Clay Mix Areas	3,352
Below-Grade Sand/Clay Mix Areas	160
Above-Grade Clay Settling Areas with Sand/Clay Mix Cap	3,185
Above-Grade Clay Settling Areas	1,642
Below-Grade Clay Settling Areas	2,095
Miscellaneous Areas (Overburden)	1,740
Total	15,194

Sand Tailings Fill Areas with Overburden Cap: The characteristics of the sand tailings fill areas with overburden cap would be similar to the proposed action. However, there would be approximately 2,000 acres less of this landform for the sand/clay mix plan.

Above-Grade Sand/Clay Mix Areas: Because of the limited volume of sand tailings available, there would be only 3,352 acres of 2:1 above-grade sand/clay mix areas for this reclamation plan. According to standard soil textural classification, sand and clay mixed in a 2:1 ratio is classified as a sandy clay loam soil. Loams are defined as soils in which none of the particle size classes dominate the soil properties. Therefore, the sandy clay loam soil produced by the sand/clay mix is expected to exhibit a blend of the properties of sand and clay. Sand/clay mix soils are projected to consolidate more rapidly and have better load bearing capacity than clay soils. However, the sand/clay mix fill areas are still projected to undergo a period of gradual subsidence as the clay component dewaters. Consequently, these areas would probably not be suited for structural development in the immediate future.

Sand/clay mix soils are projected to be good soils from an agronomic standpoint. The clay component would provide fertility, moisture holding capacity, and nutrient retention properties to the mixture, while the sand would serve to alleviate the problems of tillage and waterlogging that are associated with clay alone. These soils should be suited for a variety of agricultural uses. Improved pasture is a likely choice since forage crops can be selected that would thrive on the reclaimed soils, and the load bearing capacity of the mix should be sufficient to support the growth of mature trees. As the tillage properties of the soil improve with the development of soil organic matter, the production of row crops such as vegetables may become feasible.

Below-Grade Sand/Clay Mix Areas: The 160 acres of sand/clay mix areas would be designed for runoff retention during the wet season. These areas would be slightly above the water table and, therefore, subject to desiccation.

Above-Grade Clay Settling Areas Capped with Sand/Clay Mix: Approximately 3,185 areas of land would be reclaimed as above-grade clay fill areas with a five foot cap of 2:1 sand/clay mix. The surface soil characteristics of the sand/clay mixture would be similar to the other sand/clay mix areas described in this reclamation plan. These areas would not be as structually sound as the sand/clay mix areas.

Above-Grade Clay Settling Areas: Because insufficient sand tailings are available to reclaim all the waste clay areas with a 2:1 sand/clay mix, approximately 1,642 acres would be reclaimed as above-grade clay settling areas. The characteristics of this reclaimed landform would be similar to the description in the proposed action.

Below-Grade Clay Settling Areas: Approximately 2,095 acres of below-grade clay settling areas would be re-created as wetlands, 582 acres more than the proposed action.

Miscellaneous Areas: These areas would include overburden fill areas (733 graded spoil areas (838 acres), the backfilled clear water pond (45 acres) and the reclaimed plant site (124 acres). Soils in these areas would have the same capability as the existing soils have to support tree plantings or building foundations.

Overburden/Clay Mix Plan: The overburden/clay mix reclamation plan would utilize overburden sand as a supplement to the sand tailings in order to produce more sand/clay mix reclaimed landforms. The types of reclaimed landforms for this method are described in the following subsections and the acreages are listed as follows:

Reclaimed Landform	Reclaimed Acreage
Sand Tailings Fill Areas with Overburden Cap	3,020
Above-Grade Sand/Clay Mix (2:1) Areas	5,492
Above-Grade Clay Settling Areas with Sand/Clay Mix (2:1) Cap	2,847
Below-Grade Clay Settling Areas	2,095
Miscellaneous Areas (Overburden)	1,740
Total	15,194

Sand Tailings Fill Areas with Overburden Cap: The sand tailings fill areas with overburden cap would have the same size and characteristics as those described in the sand/clay mix plan.

Sand/Clay Mix Area: Approximately 5,492 acres, or 36 percent of the reclaimed land area, would be 2:1 sand/clay mix. The characteristics for the sand/clay mix areas would be the same as those described under the sand/clay mix alternative case.

Above-Grade Clay Settling Capped with Sand/Clay Mix: Approximately 2,847 areas of land would be reclaimed as above-grade clay fill areas with a five foot cap of 2:1 sand/clay mix. The surface soil characteristics of the sand/clay mix cap areas described in the sand/clay mix plan.

Below-Grade Clay Settling Areas: The 2,095 acres of below-grade clay settling areas would be designed for wetland re-creation. This is similar in size and characteristics to the proposed action.

Miscellaneous Areas: These areas would include overburden fill areas (733 acres), graded spoil areas (838 acres), the backfilled clear water pond (45 acres) and the reclaimed plant site (124 acres). Soils in these areas would have the same capability as the existing soils to support tree plantings or building foundations.

4.2.2.5 Water Source Alternatives (See description DEIS 2.7)

Groundwater (Mobil's Proposed Action): Groundwater withdrawal for the proposed mining operation would be primarily from the Floridan Aquifer. Dewatering would be conducted in the Surficial Aquifer in the vicinity of the mining cuts. In no case would the water table be lowered below the limestone unit; this would protect against any associated collapse of the geologic formations.

Surface Water: No significant adverse effects on the area's geology and soils would be expected as a result of using surface water as a source of water supply for the proposed mining operation.

4.3 REFERENCES

Alt, D., and Brooks, H.K., 1965. Age of the Florida Marine Terraces: Journal of Geology, V. 73, No. 2.

Altschuler, Z.S., and Young, E.J., 1960. Residual Origin of the "Pleistocene" Sand Mantle in Central Florida Uplands and its Bearing on Marine Terraces and Cenozoic Uplift: U.S. Geological Survey Professional Paper 400-B.

Bollinger, B.A., 1977. Reinterpretation of the Intensity Data for the 1886 Charleston, S.C. Earthquake. USGS Prof. Paper 1028-B.

Cederstrom, D.J., Boswell, E.H. and Tavares, G.R., 1979. Summary Appraisals of the Nation's Groundwater Resources-South Atlantic-Gulf Region. USGS Prof. Paper 813-0.

Cooke, C.W., 1945. Geology of Florida: Florida Geological Survey Bulletin 29.

McNeil, F.S., 1950. Pleistocene Shorelines in Florida and Georgia: U.S. Geological Survey Professional Paper 221-F.

Stewart, H.G., 1966. Ground-Water Resources of Polk County: Florida Geological Survey Report of Investigation No. 44.

Stover, C.W., Reagor, B.G., and Algermissen, S.T., 1979. Seismicity Map of Florida. USGS Misc. Field Studies, Map MF-1056.

Stringfield, V.T., 1966. Artesian Water in Tertiary Limestone in the Southeastern States. USGS Prof. Paper 517.

U.S. Department of Agriculture, Soil Conservation Service, March 23, 1978. Land Inventory and Monitoring Memorandum - 3 (Rev 2)

Vernon, R.O., 1951. Geology of Citrus and Levy Counties, Florida: Florida Department of National Resources, Bureau of Geology Bulletin 33

White, W.A., 1970. The Geomorphology of the Florida Peninsula: Florida Department of National Resources, Bureau of Geology Bulletin 51.

TABLE 4-1

PARTICLE SIZE DISTRIBUTION AND PLANT AVAILABLE NUTRIENT ANALYSES OF OVERBURDEN, SAND TAILINGS AND PHOSPHATIC CLAY SAMPLES

Core Sample	Sample	Particle Size Distribution				Plant Available Nutrients (lb/acre)*			
		% Sand	% Silt	% Clay	pH	Ca	Mg	P	K
R-3	0-1' Overburden	98.75	0.50	0.75	4.2	56	10	120	27
	1-15' Overburden	96.75	1.00	2.25	6.7	872	103	1,600	14
	15-16' Overburden	92.25	2.50	5.25	6.2	2,128	205	3,720	57
	+35 Mesh Sand Tailings	97.50	0.00	2.50	8.5	7,320	1,572	1,890	8
	-35 Mesh Sand Tailings	98.75	0.00	1.25	7.4	6,560	712	2,370	7
	Phosphatic Clay	**	**	**	**	**	**	**	**
R-6	0-1' Overburden	96.50	1.50	2.00	5.4	312	25	47	25
	1-15' Overburden	94.00	1.50	4.50	5.4	104	55	400	20
	15-23' Overburden	74.50	2.00	23.50	6.3	1,456	784	2,650	133
	+35 Mesh Sand Tailings	98.25	0.00	1.75	6.7	6,520	120	2,300	7
	-35 Mesh Sand Tailings	97.00	0.00	3.00	6.7	7,800	112	3,670	8
	Phosphatic Clay	40.00	7.50	52.50	7.1	7,080	1,728	1,330	492
R-7	0-2' Overburden	96.75	1.50	1.75	5.6	168	48	155	67
	2-3.5' Overburden	94.50	3.00	2.50	5.1	32	9	128	53
	3.5-8' Overburden	95.50	2.00	2.50	5.2	16	12	108	30
	8-12' Overburden	94.00	4.50	1.50	5.3	40	23	234	16
	12-12.5' Overburden	96.75	2.75	0.50	5.1	8	4	296	5
	12.5-21' Overburden	82.50	1.75	15.75	5.0	32	166	128	19
	21-25.5' Overburden	84.50	2.25	13.25	6.0	792	305	930	55
	+35 Mesh Sand Tailings	98.25	0.00	1.75	6.8	6,720	116	3,110	8
	-35 Mesh Sand Tailings	98.50	0.00	1.50	6.5	6,840	68	2,800	7
	Phosphatic Clay	33.75	2.00	64.25	7.0	6,680	1,468	1,330	308

TABLE 4-1 (Continued)

Core Sample	Sample	Particle Size Distribution			pH	Plant Available Nutrients (lb/acre)*			
		% Sand	% Silt	% Clay		Ca	Mg	P	K
R-9	0-2' Overburden	96.50	2.50	1.00	5.3	80	31	100	24
	2-4.5' Overburden	96.25	3.00	0.75	5.0	24	19	44	7
	4.5-7.5' Overburden	97.75	1.75	0.50	5.4	72	12	87	15
	7.5-12.5' Overburden	93.75	2.75	3.50	5.2	56	23	64	21
	+35 Mesh Sand Tailings	97.50	0.00	2.50	6.5	6,390	148	2,300	4
	-35 Mesh Sand Tailings	97.75	0.00	2.25	6.8	7,760	108	3,020	7
	Phosphatic Clay	23.75	11.00	65.25	7.3	5,000	1,448	280	148
R-10	0-0.5' Overburden	94.75	4.25	1.00	6.4	1,568	412	474	113
	0.5-2' Overburden	94.75	2.25	3.00	6.0	184	80	220	50
	2-15' Overburden	92.50	1.25	6.25	5.3	568	86	930	25
	15-20' Overburden	79.75	0.25	20.00	5.5	2,072	229	3,720	104
	+35 Mesh Sand Tailings	97.25	0.00	2.75	6.3	6,320	88	2,950	6
	-35 Mesh Sand Tailings	97.25	0.00	2.75	6.4	7,480	72	3,110	4
	Phosphatic Clay	35.00	9.00	56.00	7.0	6,520	1,260	1,100	164
R-11	0-1' Overburden	95.50	2.50	2.00	6.2	408	66	100	48
	1-7.5' Overburden	93.25	1.75	5.00	5.3	32	25	32	17
	7.5-17' Overburden	79.00	1.25	19.75	5.0	88	122	24	18
	17-22' Overburden	82.00	3.00	15.00	5.0	96	121	43	56
	+35 Mesh Sand Tailings	98.50	0.00	1.50	6.9	5,480	76	1,830	6
	-35 Mesh Sand Tailings	97.75	0.00	2.25	6.3	6,800	80	2,190	8
	Phosphatic Clay	35.00	7.00	58.00	6.6	6,560	1,532	1,720	300

Ca - Calcium
Mg - Magnesium
P - Phosphorus
K - Potassium

* 0.05 N HCl in 0.025 N H_2O_5 used as the extracting solution
** Sample lost

SOURCE: ZELLARS-WILLIAMS

TABLE 4-2

SOIL DISTRIBUTION

Map Symbol	Mapping Unit Name	Number of Acres	% Of Total Mapped	Topographical Features
2	Apopka Series	92	0.5	Well drained upland
3	Candler Fine Sand	603	3.5	Well drained upland
7	Pomona Fine Sand	3327	19.2	Nearly level flatwoods
11	Pits-Dumps Complex	76	0.4	Phosphate mine related
12	Quartzipsamments	68	0.4	Phosphate mine related
13	Samsula Muck	41	0.2	Depressional organic soils
14	Sparr Fine Sand	470	2.7	Poorly drained upland
15	Tavares Sand	596	3.4	Well drained upland
17	Myakka Fine Sand	3144	18.1	Nearly level flatwoods
19	Floridana Mucky Fine Sand	363	2.1	Depressional soils
20	Fort Meade Loamy Fine Sand	201	1.2	Well drained upland
21	Immokalee Fine Sand	680	3.9	Nearly level flatwoods
22	Pomello Fine Sand	36	0.2	Upland flatwoods
23	Ona Fine Sand	1503	8.7	Nearly level flatwoods
24	Chobee Clay Loam	34	0.2	Floodplain
25	Placid Fine Sand	555	3.2	Nearly level flatwoods
26	Lochloosa Fine Sand	43	0.2	Poorly drained upland
30	Pompano Fine Sand	188	1.1	Flatwoods and floodplain
31	Adamsville Fine Sand	350	2.0	Upland flatwoods
32	Tomoka Muck	286	1.6	Depressional organic soils
33	Holopaw Fine Sand	248	1.4	Floodplains and flatwoods
35	Hontoon Muck	152	0.9	Depressional organic soils
36	Basinger Fine Sand	500	2.9	Nearly level flatwoods
38	Electra Fine Sand	3	<0.05	Upland flatwoods
40	Wauchula Fine Sand	23	0.1	Nearly level flatwoods
42	Felda Fine Sand	544	3.1	Floodplains and flatwoods
44	Paisley Variant Fine Sand	3	<0.05	Floodplains
47	Zolfo Fine Sand	1732	10.0	Somewhat poorly drained upland
48	Manatee Loamy Fine Sand	19	0.1	Depressional soils
57	Slickens	194	1.1	Phosphate mine related
67	Bradenton Fine Sand	277	1.6	Floodplains and flatwoods
68	Arents	35	0.2	Phosphate mine related
71	Felda Variant Fine Sand	248	1.4	Floodplains and flatwoods
72	Bradenton-Bluff-Felda Association	721	4.1	Floodplains
TOTAL		17,355*	99.7	

* Includes outparcels located within the site

SOURCE: POLK COUNTY SCS

TABLE 4-3

DESCRIPTION OF POTENTIAL RECLAIMED LANDFORMS

Landform	pH Range (units)	Plant Available Nutrients (lbs/acre)				Descriptive Comments
		Ca	Mg	P	K	
Sand tailings fill area with overburden cap	4.2 -6.7	451	119	654	41	Good structural stability Good internal drainage, very low moisture retention capacity Favorable agronomic properties*
Above-grade clay settling area, uncapped	6.6 - 7.3	6,368	1,487	1,152	282	Poor structural stability Excellent moisture and nutrient retention capacity Subject to waterlogging in wet season High nutrient availability Difficult to cultivate
Above-grade clay settling area with sand cap	6.3 - 8.5	6,833	273	2,628	7	Sand cap enhances structural stability of above-grade settling areas Low moisture and nutrient retention capacity Agronomic properties limited to seasonal forage production
Below-grade clay settling area	5.6 - 7.3	6,368	1,487	1,152	282	Designed specifically for wetland reclamation Consists of areas of open water adjoined by seasonally flooded zones
Above-grade clay settling area with sand/clay mix (4:1) cap	6.3 - 8.5	6,740	516	2,333	62	Sandy loam soil (standard soil textural classification) Load bearing capacity greater than clay soils Not suited for immediate structural development but sufficient to support growth of mature trees Good moisture and nutrient retention capacity Good internal drainage Favorable agronomic properties
Above-grade clay settling area with overburden cap	4.2 - 6.7	451	119	654	44	Good moisture and nutrient retention capacity Poor structural stability Good nutrient availability Favorable agronomic properties
Above-grade sand/clay mix (2:1) area	6.3 - 8.5	6,678	676	2,136	99	Sandy clay loam soil (standard soil textural classification) Load bearing capacity greater than clay soils Not suited for immediate structural development but sufficient to support growth of mature trees Good moisture and nutrient capacity Poor internal drainage Favorable agronomic properties
Above-grade clay settling area with sand/clay mix (2:1) cap	6.3 - 8.5	6,678	676	2,136	99	Sandy clay loam soil (standard soil textural classification) Not suited for immediate structural development but sufficient to support growth of mature trees Good moisture and nutrient capacity Poor internal drainage Favorable agronomic properties
Overburden fill area	6.2 - 6.7	451	119	654	41	Good structural stability Good internal drainage Favorable agronomic properties

Abbreviations:

Ca - Calcium	P - Phosphorus
Mg - Magnesium	K - Potassium

SOURCE: STUDY DATA

5.0 RADIATION

5.1 THE AFFECTED ENVIRONMENT

5.1.1 RADIATION AND THE ENVIRONMENT

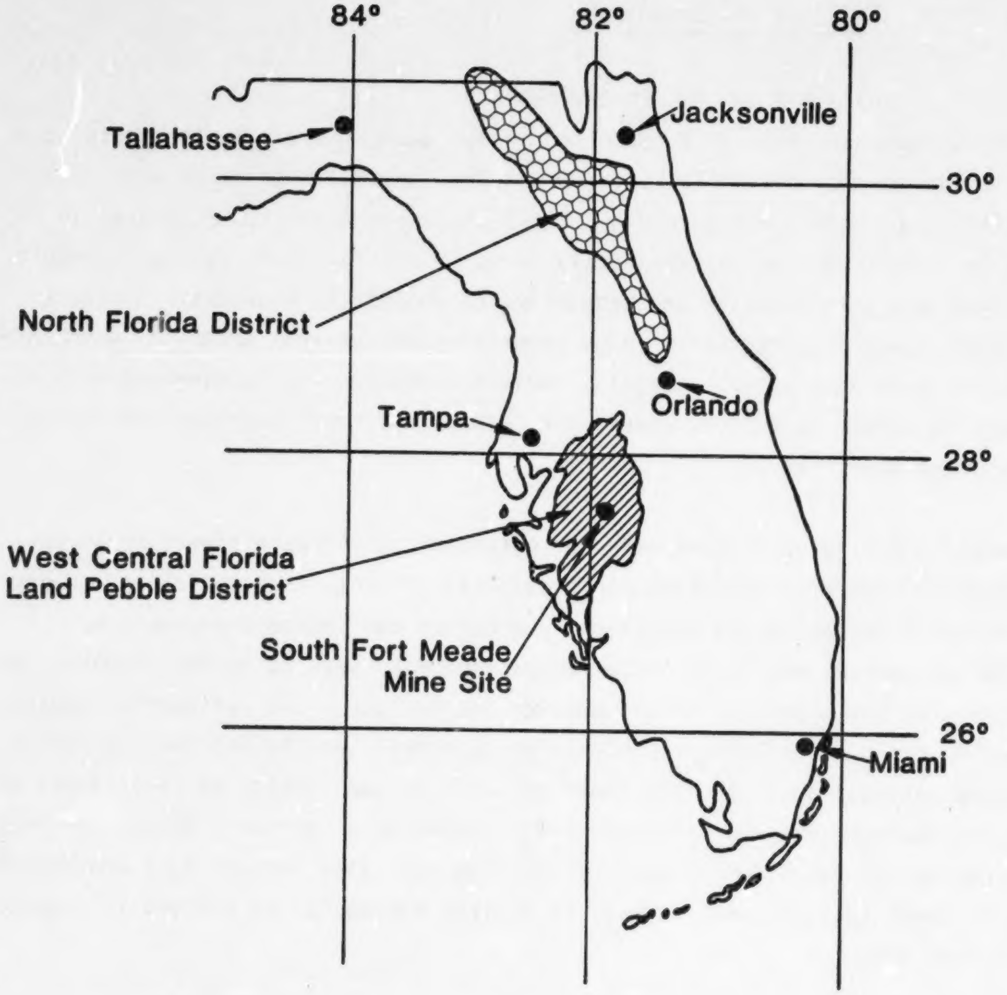
Florida Phosphate mining is conducted in two general areas in the state, the North Florida Phosphate District and the West Central Florida or Bone Valley district, as shown in Figure 5-A. These phosphate deposits originated in the Middle Miocene period (approximately 20 to 25 million years ago) as a result of undersea precipitation and deposition of phosphatic minerals. As these minerals generally exhibit uranium concentrations several orders of magnitude greater than most other materials, ambient radiation levels elevated with respect to normal background levels can result from the mining and processing of phosphate deposits.

Phosphate mining operations have the potential to increase direct human exposure to naturally occurring radioactivity. Mining, transportation and processing of the phosphate matrix and overburden can increase exposure by allowing gaseous and particulate radioactive materials to become airborne, by increasing the potential of groundwater and surface water radioactive contamination through leaching and suspension by runoff, and by introducing radioactive material into the food chain through the application of fertilizers or the inadvertent contamination by irrigation water or airborne dust. The exact mechanism and dangerous dosages of ionizing radiation are not well understood; it is known that permanent damage to healthy humans can be avoided if dosages are kept low.

The Areawide EIS and its supplements give an in-depth description of the nature of radioactivity, its potential environmental effects, its presence in central Florida phosphate deposits, and the means used for measuring its

FIGURE 5-A

LOCATION OF FLORIDA PHOSPHATE DISTRICTS



SOURCE: ASSOCIATION OF FLORIDA PHOSPHATE CHEMISTS

presence and assessing its effects (EPA, 1978). The conclusion in the Areawide EIS is that the radioactive isotopes of environmental importance to the central Florida phosphate mining industry are those in the Uranium-238 decay series. This is because of their abundance in the soils and phosphate ore, and the tendency of certain daughter isotopes to either accumulate in human tissue and/or be readily transported as a gas. These radioisotopes will be given detailed consideration in this section.

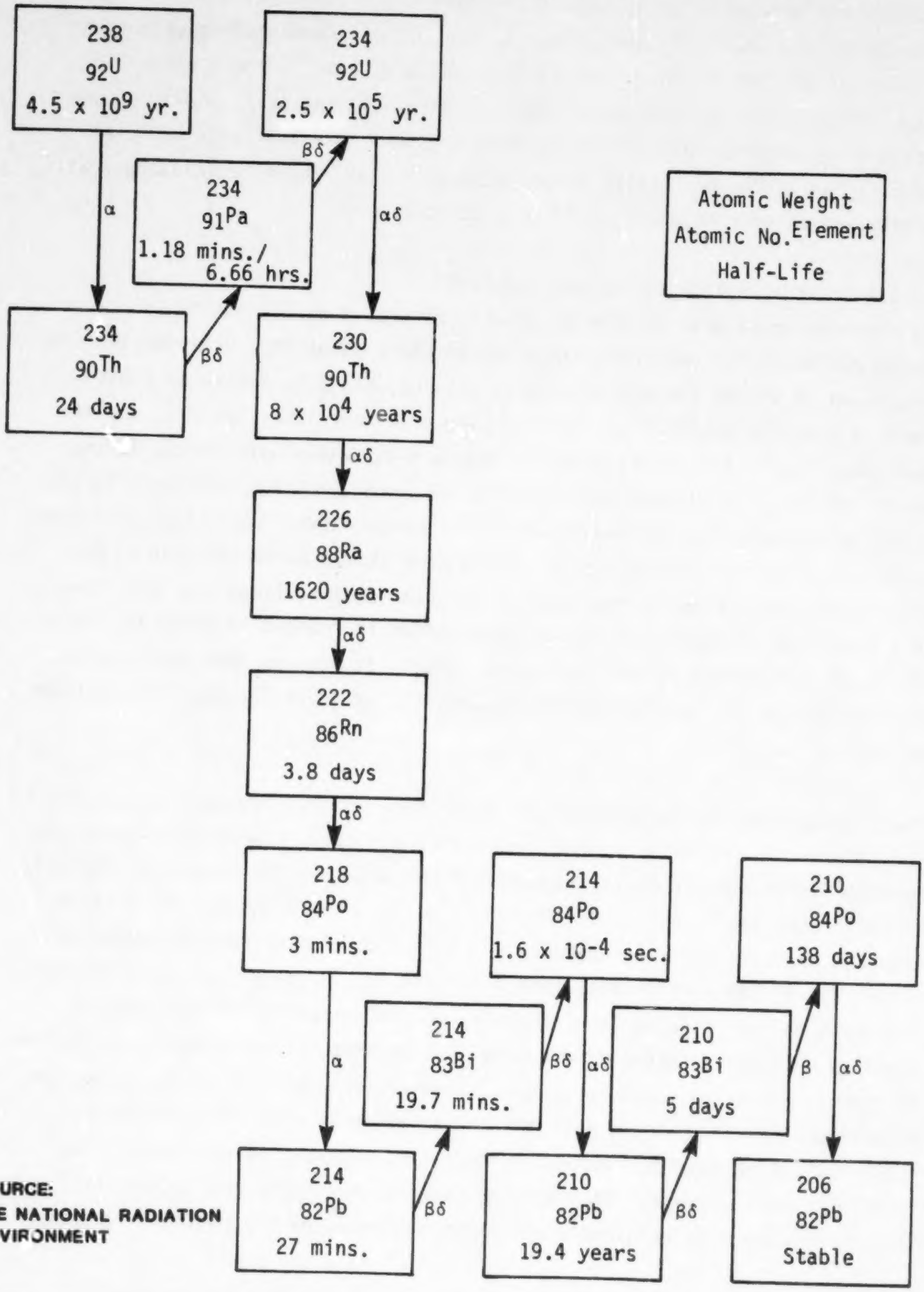
5.1.1.1 Uranium, Radioactivity and Exposure

The association of uranium with phosphatic mineral deposits is the source of almost all naturally occurring radiation in these deposits. Uranium-238, comprising 99.28 weight percent of mineral uranium, has a half-life of 4.5×10^9 years, a specific activity of 0.33×10^6 picocuries per liter (pCi/l), and decays according to the series shown in Figure 5-B. Since uranium-238 is the parent radionuclide for the entire family of decay products, its specific activity establishes the concentration of its progeny under conditions of radioactive equilibrium. The nature of radioactive decay, as depicted in Figure 5-B implies that if the parent and its daughter radionuclides are maintained in a sealed environment, a state of equilibrium is reached in which the activities of each member of the series are equal. It appears that such equilibrium exists in undisturbed phosphate deposits, at least for the radionuclides through radium-226.

The radionuclides in the uranium series of greatest interest to human exposure are radium-226, its decay product radon-222, and radon's sequential decay products polonium-218, lead-214, bismuth-214 and polonium-214 (known collectively as the "radon daughters"). Radium-226 is of the same elemental group as calcium and exhibits a strong tendency to replace calcium in bone and other environments. It has a relatively long half-life (1,620 years) and may enter the body through ingestion of food or water containing radium, or by breathing airborne dust contaminated with radium. While immobilized in the soil, radium-226 causes radiation exposure by generation of radon-222. This inert gas can diffuse upwards through the soil and become airborne. In the atmosphere, radon-222 may be inhaled, increasing radiation exposure to the lungs. The radon daughters, although they are not gaseous, enter the body primarily through the lungs as respirable particles generated by the radioactive decay

FIGURE 5-B

URANIUM-238 DECAY SERIES



SOURCE:
THE NATIONAL RADIATION ENVIRONMENT

of airborne radon. These five elemental radionuclides are responsible for the majority of human exposure to radioactivity associated with phosphate mining.

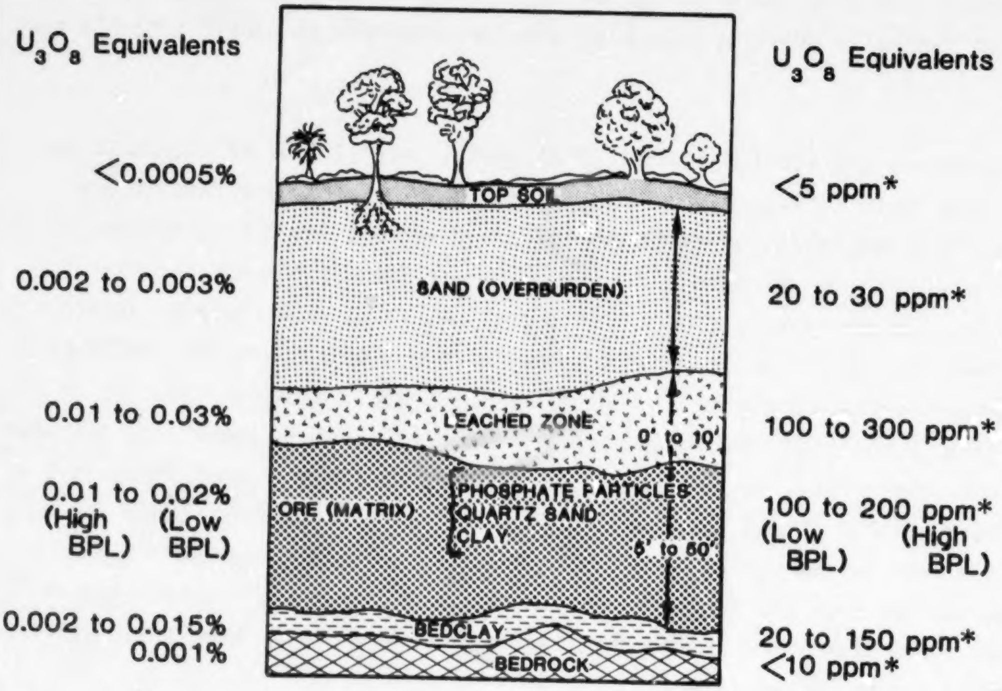
5.1.1.2 Uranium and Phosphate Deposits

Uranium present in the marine environment in the Middle Miocene period was deposited along with the primary phosphatic mineral apatite, with a chemical formula of $Ca_5(PO_4)_3(F,Cl,OH)$. Apatite typically exhibits uranium concentrations of 0.005 to 0.02 percent, while most other minerals have maximum concentrations in the phosphatic matrix of a few parts per million, with normal concentrations of a few parts per billion. In contrast, commercial mining of uranium generally exploits ores with uranium concentrations of 0.1 to 0.4 percent.

The structure and uranium content of a typical central Florida phosphate deposit are shown in Figure 5-C. The soils above the phosphate deposit are generally mixed strata of sands and clays and exhibit low concentrations of radionuclides. Immediately above the matrix, a zone of leached material is usually, but not always present. This zone may or may not contain leached phosphate ore which results from groundwater movement through the phosphate matrix, converting the matrix to aluminum phosphate. Aluminum oxide is an undesirable impurity in a phosphate rock product. Where a leach zone has been created, the uranium concentrations of that zone are higher than those in the overburden above it and the leach zone is typically not mined. Leach zone material can be segregated from matrix and overburden and replaced in the bottom of the mine pit where the matrix has been removed. This process, referred to as leach zone management, serves to redeposit the more radioactive material at its former depth.

The phosphate matrix is composed of the phosphatic minerals, quartz sands and nonphosphatic clays in roughly equal proportions. After mining, the matrix is subjected to beneficiation processes to yield the phosphate rock product. Generally, the matrix is slurried and screened, producing a coarse pebble product. The remaining slurry is further screen-separated to yield a waste clay fraction and two intermediate portions. The intermediate portions are processed by flotation and result in waste sand tailings and rock concentrates. The tailings are typically disposed of, along with the overburden, in mined

AVERAGE URANIUM CONCENTRATIONS AS U_3O_8 IN TYPICAL CENTRAL FLORIDA PHOSPHATE DISTRICT PROFILE



*ppm = Parts Per Million

SOURCE: EPA, 1978

areas. Waste clays are impounded to facilitate dewatering on either mined or unmined land.

Uranium concentrations in the phosphate fractions differ greatly. Roessler, et al., found an approximate 20 percent increase in uranium concentration in pebble product over the matrix, and a 20 percent decrease for rock concentrate. Tailings exhibited uranium concentrations of 12 percent of the matrix, while waste clays exhibited uranium concentrations of 10 percent of the matrix. These figures are presented in Table 5-1 (Roessler et al., 1979).

5.1.1.3 Mining and Radiation

Reclaimed land has the potential to exhibit greater radioactivity than unaltered land. This potential is affected by such factors as the presence or absence of leach zones, leach zone management techniques employed, the amount of overburden present and the waste disposal/reclamation techniques employed. Values of various radiological parameters for several types of reclaimed land are given in Table 5-2. Debris lands show the highest activities, followed by land reclaimed by waste clays. Debris lands were reclaimed before the development of flotation technology to separate the rock concentrates from sand, and so contain large amounts of phosphate and uranium.

The reclamation of mined areas has the potential to permanently increase background radioactivity through the replacement of overburden and the disposal of waste clays and sand tailings in open mining pits. In reclamation, the strata above the leached zone which usually exhibit low radioactivity are removed and, in the past, were often mixed with the more radioactive leached zone materials. When these were replaced, the resulting soil had a higher overall radioactivity and greater radon exhalation potential than the premining soils.

Of particular concern is the ability of structures built on reclaimed areas to serve as concentrators of radon and the radon daughters. Mixing and moving overburden during reclamation irreversibly alters the soil structure and can result in greater surface and near-surface concentrations of radionuclides. Since dispersion inside structures is limited, radon entering the structures by upward diffusion through the soil and foundations is trapped inside, resulting in increased radiation exposure to the occupants of those buildings. Guimond et al., found average indoor exposure to radon progeny in structures built on reclaimed land to be some five times greater than in structures on non-mineralized land. Interestingly, they also found that unmined, mineralized land has a radiological impact as great as mined, reclaimed land (Guimond et al., 1979).

Several techniques have been developed to mitigate the radiological impact of reclamation. These primarily involve covering the bulk of the fill material with a layer of low activity overburden. Other techniques involve disposing of waste clays and sand tailings simultaneously, thus lowering the radionuclide activity of the clays by dilution.

5.1.2 RADIATION EXISTING AT THE SITE

Accurate assessment of the impact of Mobil's proposed South Fort Meade Mine on the site's radiological environment requires a thorough knowledge of the baseline conditions in the area. To fully describe the distribution, intensity and type of naturally occurring radiation on the study area, seven types of site specific data were collected: (1) study of the surface and near-surface soils, (2) establishment of the radiological profile of the mined section, (3) analysis of the phosphate matrix and its various fractions, (4) study of the structures underlying the mined section, (5) analysis of the area's surface water, (6) analysis of the various groundwater resources within the mining area, and (7) analysis of uranium-series radionuclides uptake by biological systems.

5.1.2.1 Surface and Near-Surface Soils

Radioactivity in the upper soil contributes to exposure in several ways. Gamma-emitting species contribute directly to ambient radiation levels. Radium-226 in upper soil layers generates most of the radon-222 that is exhaled into the atmosphere, and radium and other radioactive species near the surface can be suspended in the air or carried in groundwater or surface water. All of these avenues can lead to increased human exposure. To determine the baseline levels of upper soil radioactivity the following were carried out: (1) a gamma survey was performed over the entire tract, (2) surface soils were sampled and analyzed, and (3) radiological profiles of near-surface soil were examined.

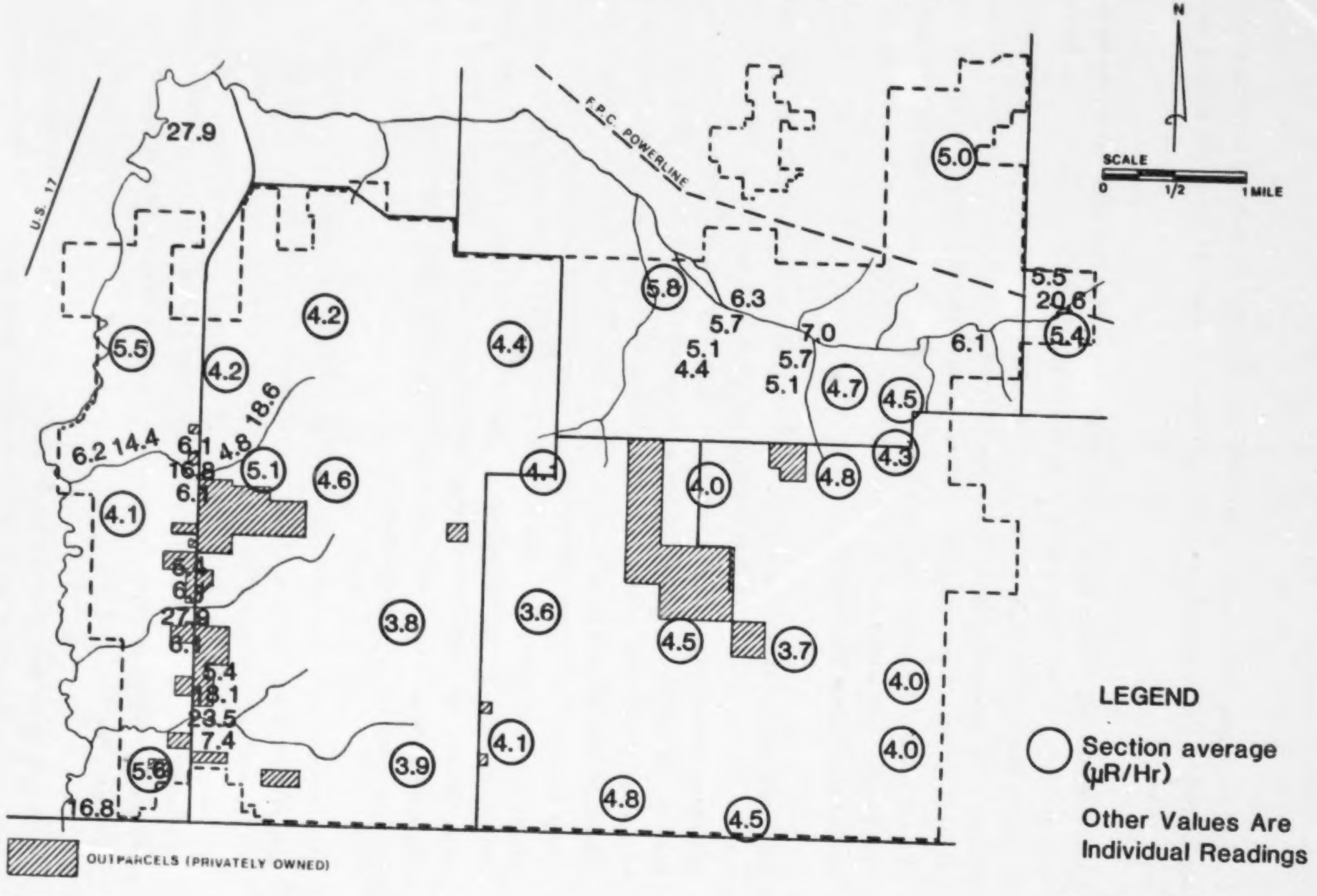
Direct gamma radiation exposure over the proposed mining area was determined by measuring incident gamma with a portable scintillation meter at intervals of approximately 50 yards along transects approximately one meter above the ground. The external gamma survey not only measured direct exposure levels, but also served to estimate soil radium content in the area. The survey also allowed identification of radioactive anomalies and areas of particular concentration. The gamma survey provided a guide for soil sampling and interpretation of sampling results.

The gamma survey showed levels of 3.5 to 5.5 microroentgen (uR) per hour over most of the tract with an overall average of 4.4 uR per hour. Enhanced radiation levels were noted where local geography brought deeper strata with greater radioactivity closer to the surface along creek beds. This increase in radioactivity was around 40 percent along Bowlegs Creek in the northeastern corner of the site, and as much as 400 to 600 percent along the western edge. Gamma survey results are presented in Figure 5-D and Table 5-3. These radiation levels are low, representing only a small increase over the cosmic radiation level of 2.6 uR per hour. Comparison of these data with the typical gamma levels for undisturbed lands in central Florida (Table 5-2) shows the South Fort Meade site generally lower in surface gamma radiation levels than similar land types in this region.

Soil samples were collected at 16 sites (Figure 5-E) and radium-226 concentrations were recorded (Table 5-4). Concentrations ranged from 0.2 to 1.1 pCi/g, with an average of 0.4 pCi/g. Values generally correlated well with the observed gamma radiation levels. The average is almost identical to the area-wide average for undisturbed lands, but the maximum radium-226 content at the South Fort Meade site is about one third of the maximum observed in central Florida.

Nine locations were sampled to determine near-surface soil radioactivity. Cores were taken to a depth of six feet at these sites. If the water table

GAMMA SURVEY RESULTS



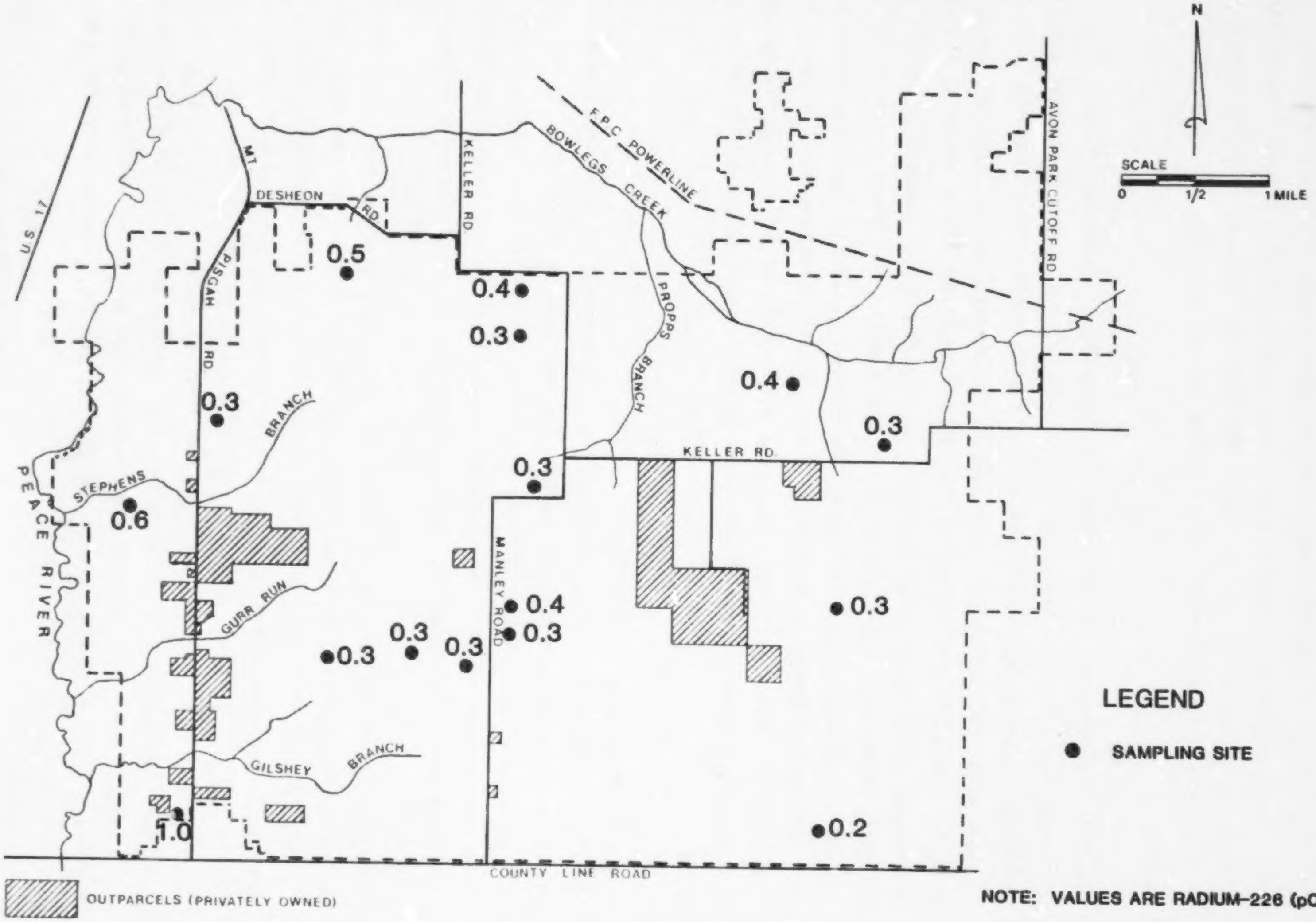
LEGEND

○ Section average (μR/Hr)

Other Values Are Individual Readings

SOURCE: STUDY DATA

RADIOACTIVITY OF SURFACE SOIL



NOTE: VALUES ARE RADIUM-226 (pCi/g)

SOURCE: STUDY DATA

FIGURE 5-E

allowed, the cores were sectioned into one-foot segments before analysis. Again, radium-226 concentrations were low, ranging from 0.2 to 0.4 pCi/g with an average of 0.3 pCi/g for the upper one-foot of soil, and ranging from 0.2 to 1.0 pCi/g with an average of 0.6 pCi/g for the five-foot to six-foot samples.

The radiological profiles fell into two groupings. One grouping maintained a uniformly low activity throughout the six-foot depth, while the other group exhibited activity that increased slightly with depth. This behavior correlated with the two general soil types of the area, one in which the sandy soil is underlain by clay within the top six feet and one in which it is not. The deeper sands, with no clay within the top six feet, showed a uniformly low activity throughout their depth, while those with clay showed a slight increase in radioactivity with depth. In general, external gamma radiation levels and surface and near-surface soil radium concentrations were low over the entire site. Some localized areas of significantly higher radioactivity were present where erosion had brought more active formations closer to the surface.

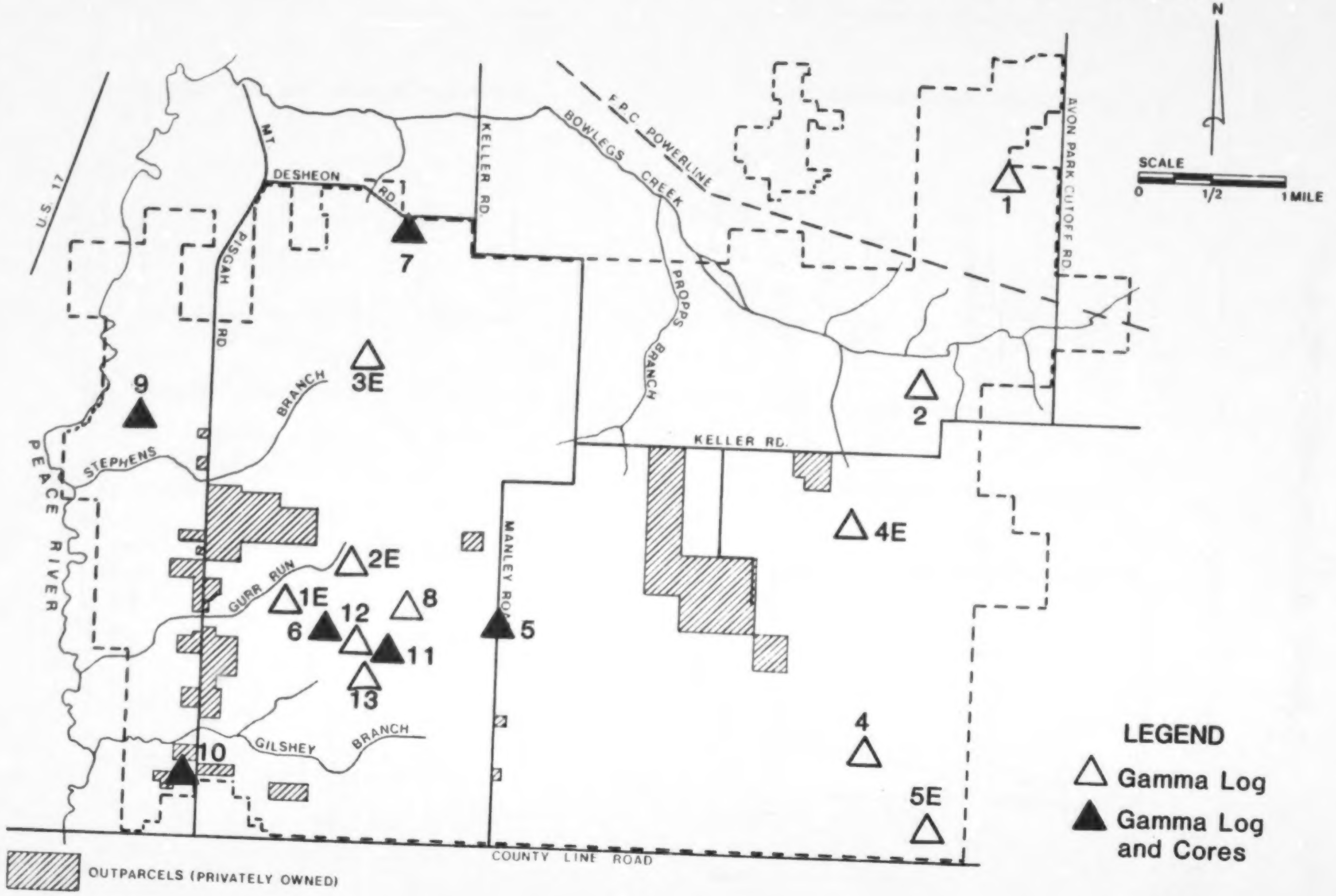
5.1.2.2 Mined Section Profile

During the phosphate mining process, large quantities of overburden must be displaced, stored and finally replaced as the land is reclaimed. To evaluate the potential radiological effects of overburden disruption, radioactivity from the surface through the phosphate-bearing matrix was determined by core sampling and analysis and by gamma logging at the points shown in Figure 5-F.

Cores were drilled through the matrix at six sites in the study area. Phosphate matrix portions were separated from the overburden and sampled. The overburden was sectioned and composite samples were also prepared. The radium-226 concentration profiles are presented in Figure 5-G and summarized in Table 5-5. Although each site exhibited significant differences, a general pattern was shown of low activity (less than or equal to 1.0 pCi/g) at the surface, increasing gradually through the overburden to 1.0 to 8.0 pCi/g above the leached zone. If present, the leached zone exhibited widely varying radioactivity (3.0 to 60 pCi/g). In the matrix, however, composite matrix averages at the six sites ranged from 12 to 22 pCi/g.

FIGURE 5-F

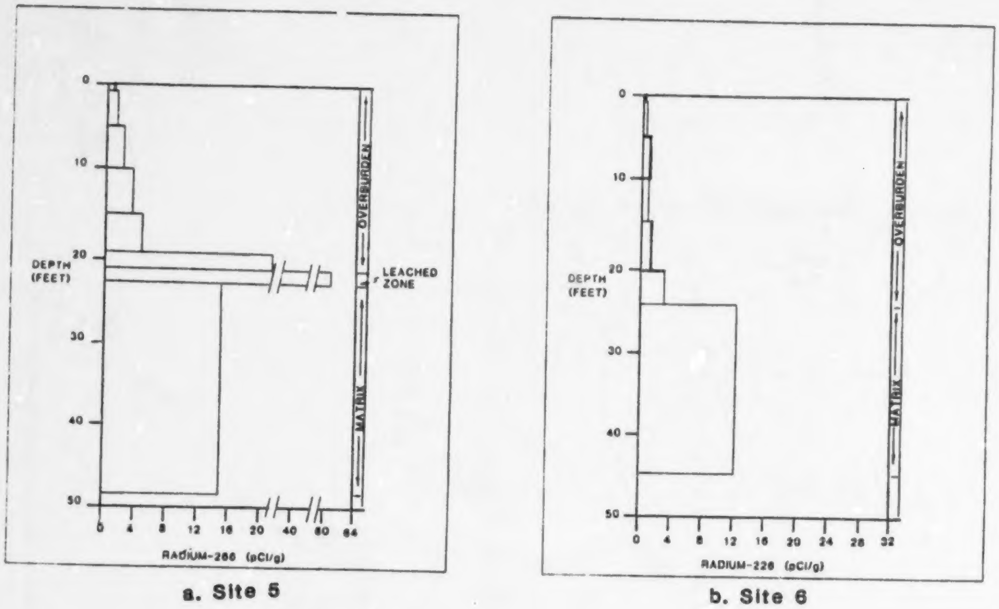
LOCATION OF CORE AND GAMMA LOG SITES



SOURCE: STUDY DATA

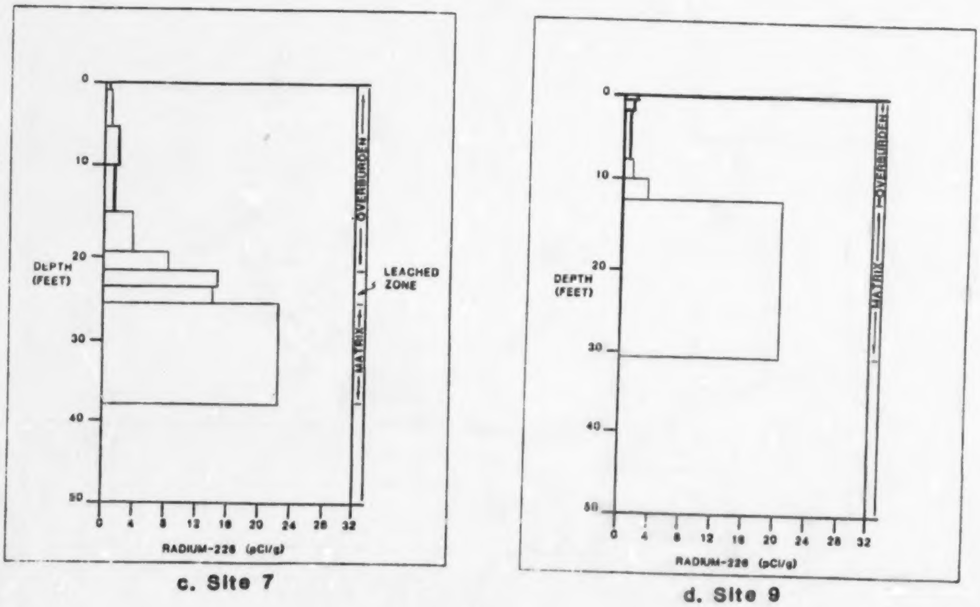
FIGURE 5-G
1 of 2

MINED SECTION RADIUM PROFILES



a. Site 5

b. Site 6



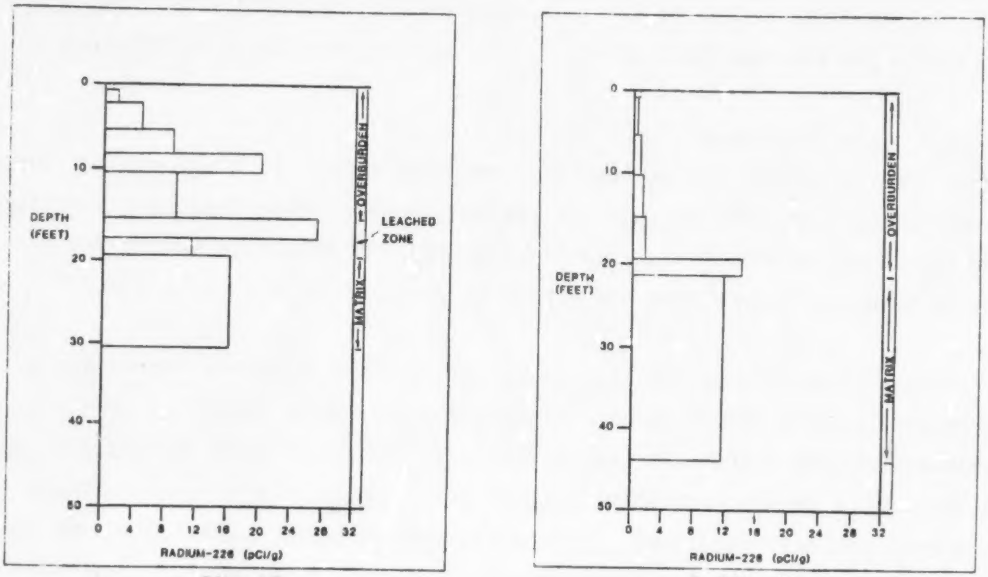
c. Site 7

d. Site 9

FIGURE 5-G
2 of 2

MINED SECTION RADIUM PROFILES

(CONTINUED)



e. Site 10

f. Site 11

SOURCE: STUDY DATA

Gamma ray logs were available for 17 wells on the Mobil site. As with the surface gamma survey, gamma intensity in the well serves as a measure of radium-226 in the surrounding material. Thus, the sites which were both sampled and logged yield a relationship between gamma intensity and radium-226 concentration which can be extrapolated to the sites where only logging data are available. The portions of the logs corresponding to the core samples are shown in Figure 5-H. The same general pattern can be determined, although the sites differ.

Using both sampling results and gamma logs, a generalized profile was developed and is presented in Figure 5-I. Radium-226 isopleths were constructed for two cross sections through the tract, and are presented in Figure 5-J.

5.1.2.3 Matrix and Fractions

After removal of the overburden, the phosphate matrix is mined and put through benefication processes to separate the phosphate portion from sand and clay wastes. Analysis of the various fractions of the phosphate matrix was performed in order to evaluate the effect of disposal in the study area.

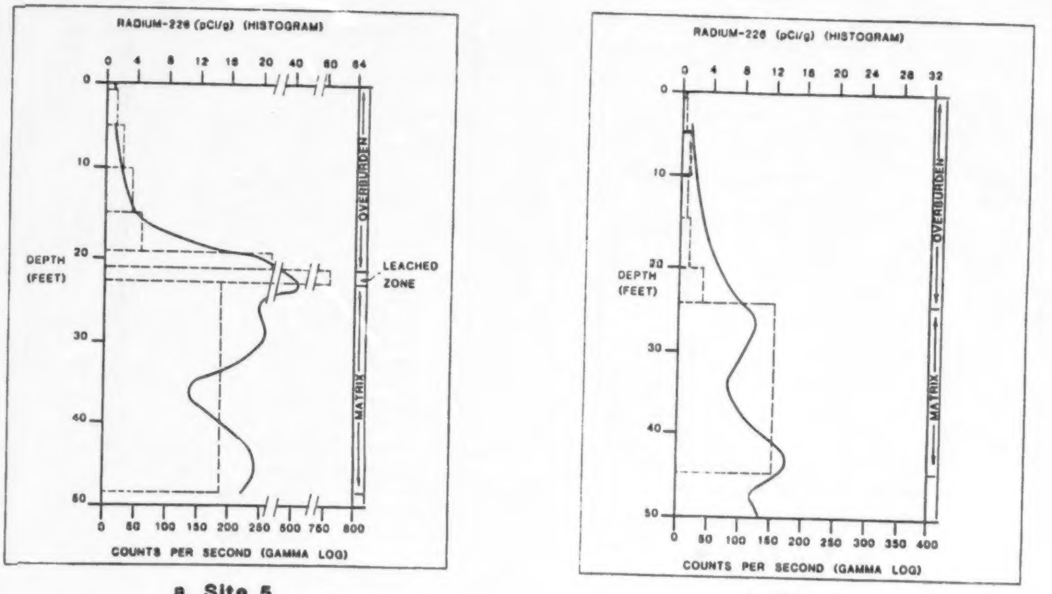
The matrix samples obtained at the six coring sites shown in Figure 5-F were subjected to pilot plant benefication, and the various fractions were analyzed to determine the radium-226 concentrations. These fractions included a composite matrix sample, phosphate pebble, clays, + 35 mesh (flotation feed, concentrate, and tailings), and -35 mesh (flotation feed, concentrate, and tailings). The analysis results for the six locations are presented and summarized in Table 5-6.

The radioactivity of the matrix and its fractions is fairly consistent from site to site. In general, the matrix averages 16 pCi/g and initially separates into 37 pCi/g pebble, 22 pCi/g (dry basis) waste clay suspension and two flotation feeds. The coarser 28 pCi/g feed yields a 36 pCi/g concentrate and 12 pCi/g tailings; the finer 8.0 pCi/g fraction yields a 28 pCi/g concentrate and 3.0 pCi/g tailings.

Comparing these values to those reported in Sections 5.1.1.2 and 5.1.1.3 for central Florida phosphate materials, the South Fort Meade site shows somewhat

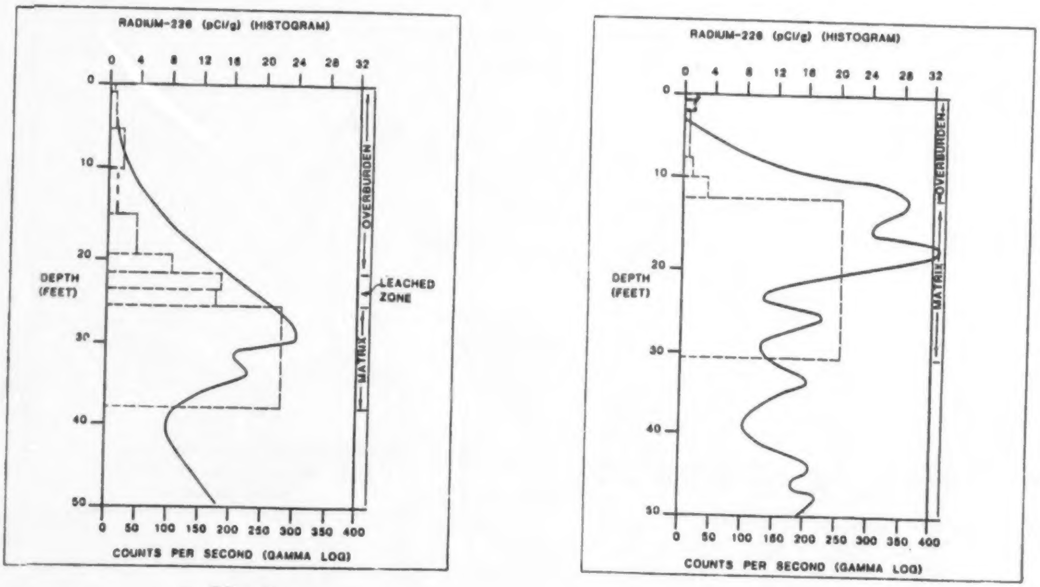
FIGURE 5-H
1 of 4

MINED SECTION GAMMA LOGS



a. Site 5

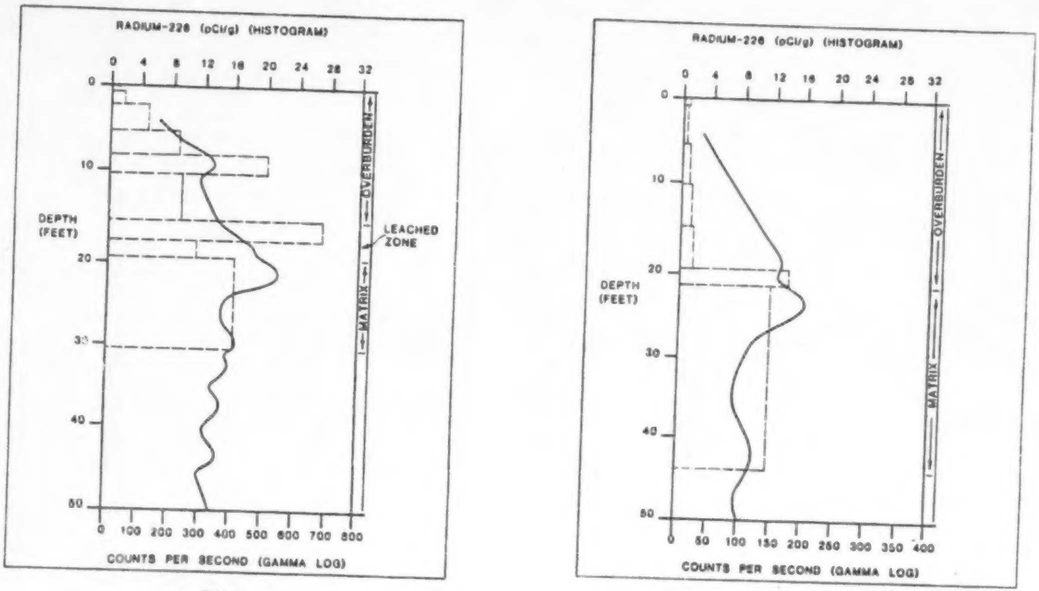
b. Site 6



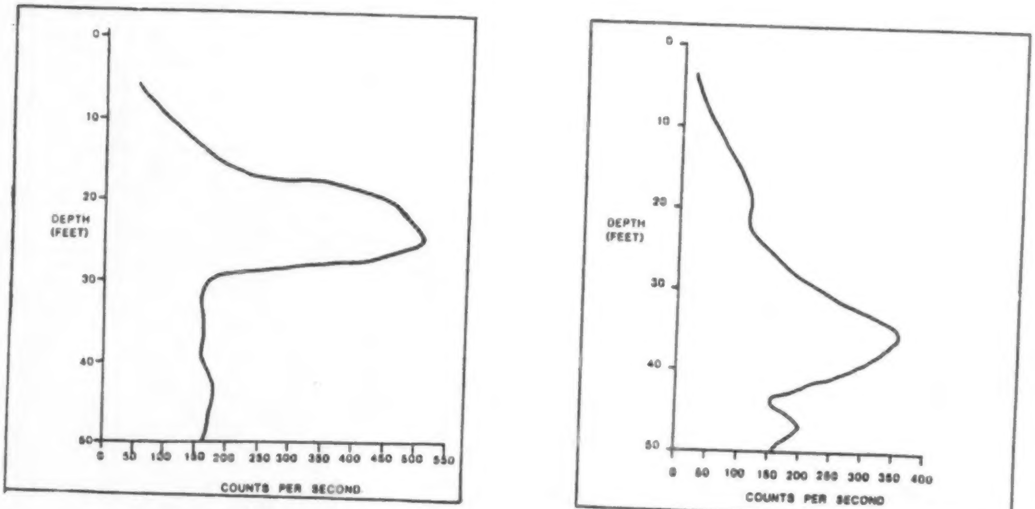
c. Site 7

d. Site 9

MINED SECTION GAMMA LOGS (CONTINUED)

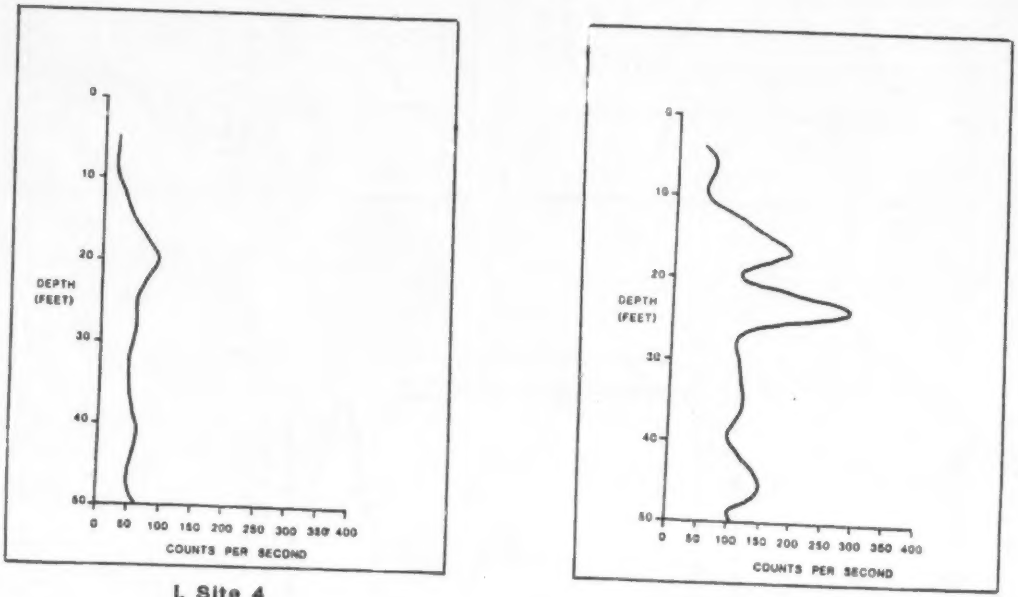


e. Site 10 **f. Site 11**



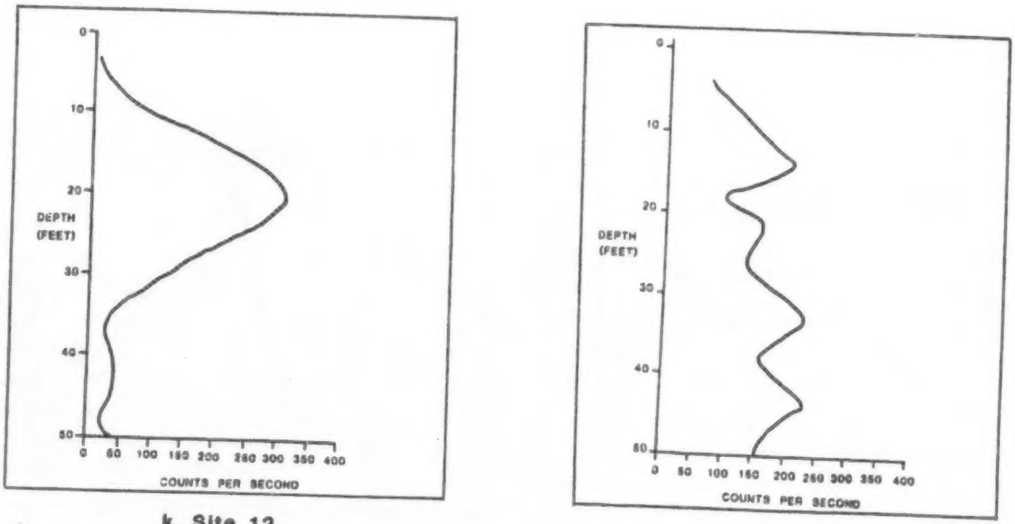
g. Site 1 **h. Site 2**

MINED SECTION GAMMA LOG (CONTINUED)



i. Site 4

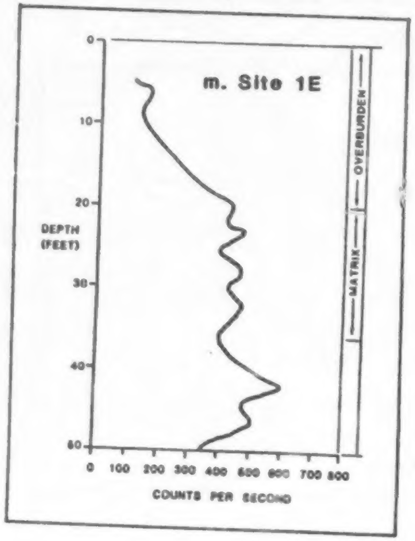
j. Site 8

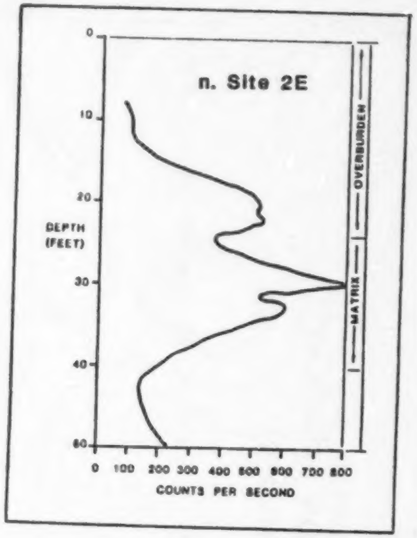


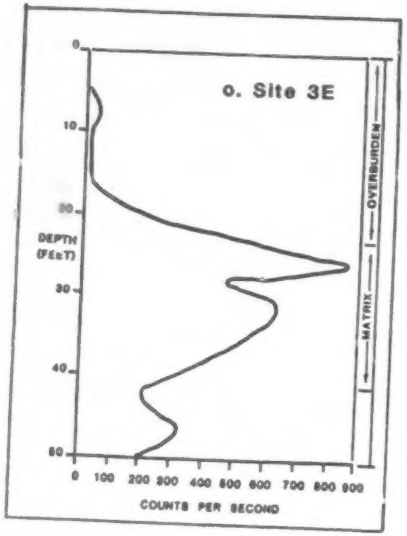
k. Site 12

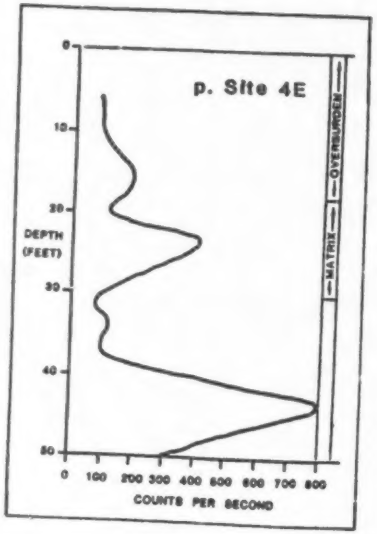
l. Site 13

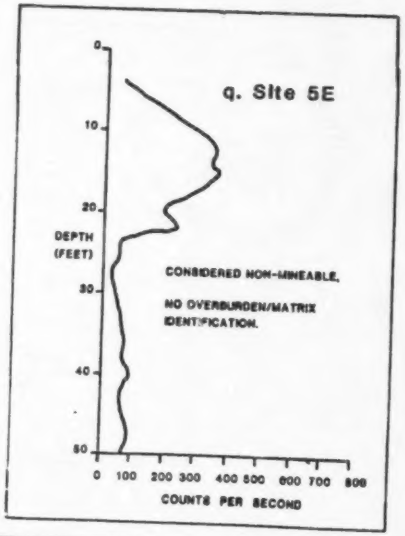
MINED SECTION GAMMA LOGS
(CONTINUED)







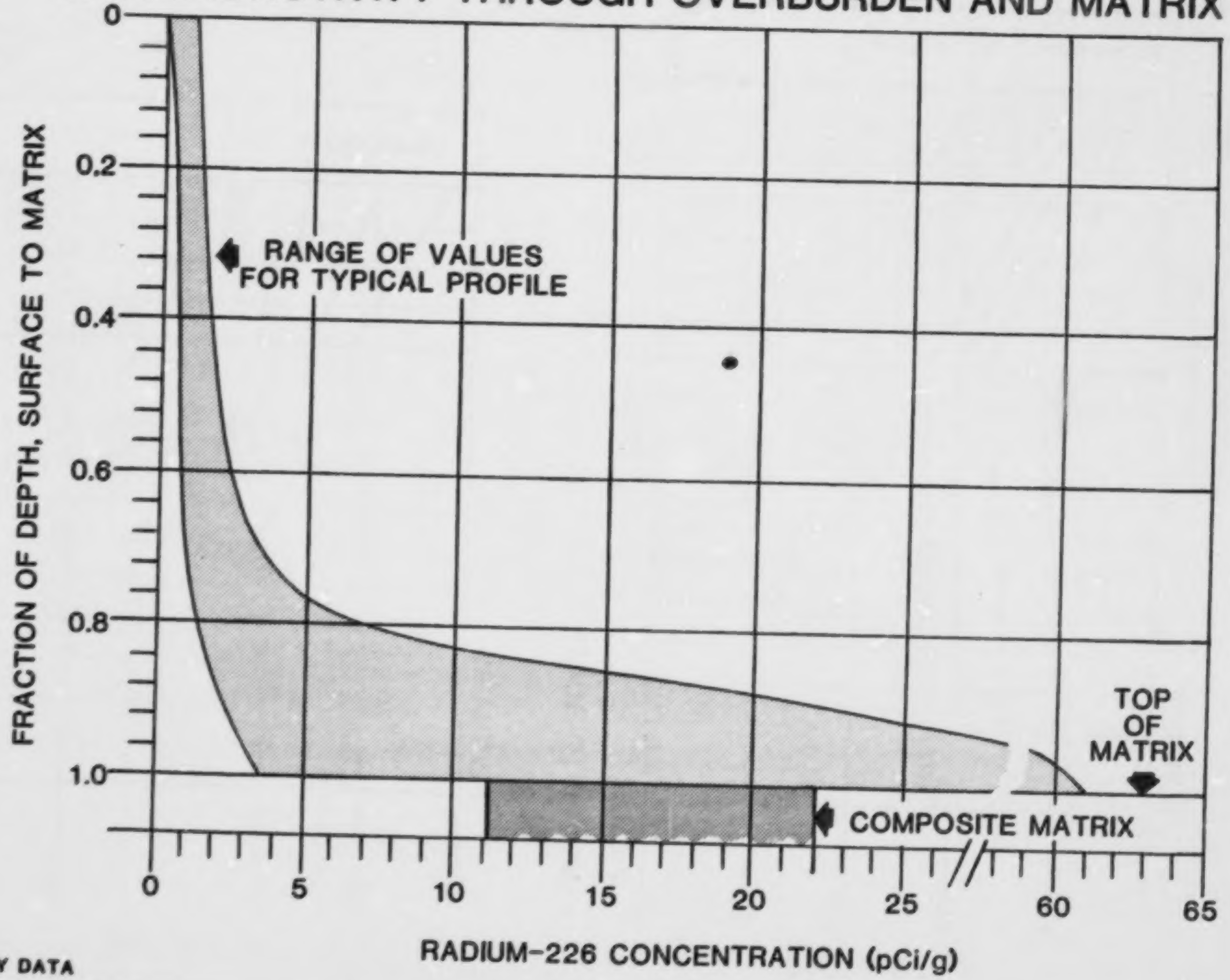




SOURCE: STUDY DATA

FIGURE 5-I

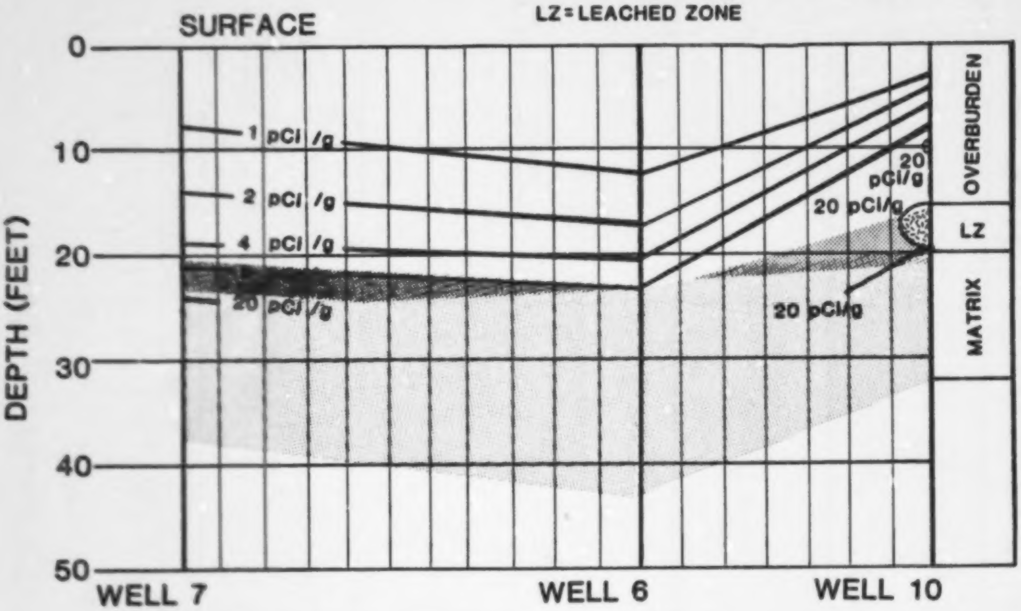
GENERALIZED PROFILE OF RADIOACTIVITY THROUGH OVERBURDEN AND MATRIX



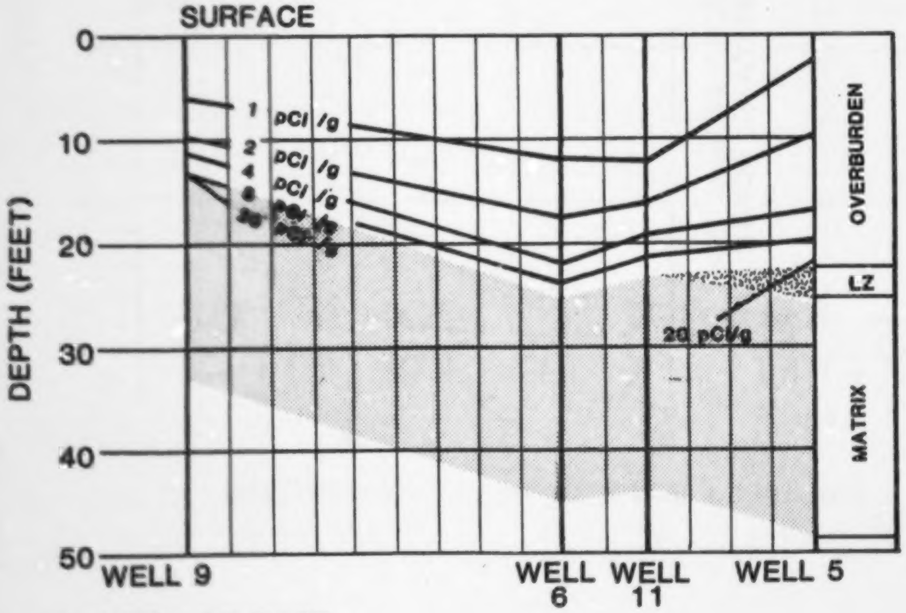
SOURCE: STUDY DATA

RADIOACTIVITY CROSS SECTIONS

NOTE:
CONCENTRATIONS ARE FOR RADIUM-226
LZ = LEACHED ZONE



a. NORTH TO SOUTH



b. WEST TO EAST

SOURCE: STUDY DATA

lower radium-226 concentrations in the composite matrix and pebble product. In both cases, the site's values are below the range of values reported by Roessler. The waste clays, rock concentrates and sand tailings had radium-226 concentrations within Roessler's reported values, although they were generally near the lower end of that range. In all, radium-226 concentrations in the tract's phosphate matrix seem to be somewhat lower than the average for the Bone Valley district.

5.1.2.4 Deep Section

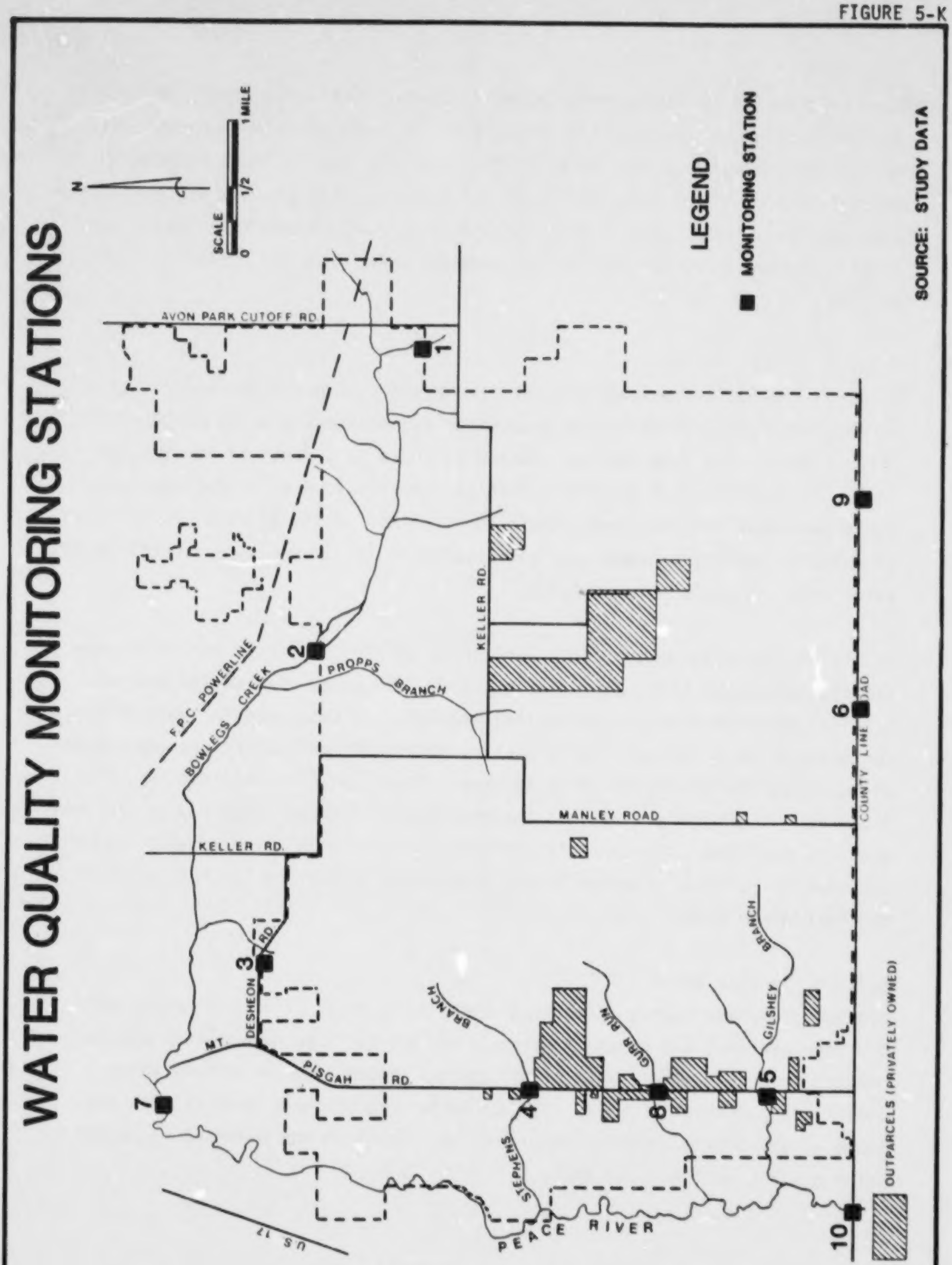
Baseline radioactivity levels in the strata underlying the phosphate matrix were determined by studying the production and monitoring wells on the tract (Figure 5-F). The deep section studied extended to a depth of about 1,200 feet. The radiological profile serves to identify sources of radioactivity in the groundwater and provides a basis for determining the effects of mining on groundwater quality. Gamma logs were available for 17 wells, and cuttings and water from six wells were analyzed.

As six of the wells on the tract were being drilled, cuttings and water were sampled, separated and analyzed at 100-foot intervals. Radium-226 concentrations were measured in the cutting samples, and water samples were analyzed for gross alpha activity. Additionally, radium-226 concentrations were determined in one-fourth of the water samples. These results are shown in Table 5-7. Radium-226 and gross alpha concentrations were uniformly low in the deep sections examined. The concentrations of radium-226 in the deep well cuttings are similar to those observed in the overburden (minus the leached zone) at the Fort Meade site.

5.1.2.5 Surface Water

Because phosphate mining operations drastically alter local topography and drainage patterns and expose previously buried soils to dissolution and suspension by runoff, the impact of mining and reclamation on surface water quality is potentially great. Surface water and sediment samples were analyzed at the points shown in Figure 5-K to establish the existing radiological water quality in the study area.

FIGURE 5-K



WATER QUALITY MONITORING STATIONS

SOURCE: STUDY DATA

Water samples were taken monthly from May to December, 1979 and were analyzed for gross alpha activity. All samples which exhibited alpha activity greater than 5.0 pCi/l, plus sufficient additional samples to comprise 25 percent of the total samples collected, were analyzed for radium-226 concentration. These results are presented in Tables 5-8, 5-9 and 5-10. A single sediment sample was collected at each water sampling station at the end of the sampling program. These were analyzed for radium-226 concentration, and the results are presented in Table 5-11, along with the average surface water radioactivities.

In general, the surface water radioactivity was low. Approximately 30 percent of the samples exhibited activities below the minimum detectable level (about 1.0 pCi/l), and the overall average was less than 1.7 pCi/l. Significant variability between sampling sites and a slight tendency for higher radioactivity in the winter months of the year were noted. Sediment radium-226 concentrations also were quite low, averaging 2.6 pCi/g, although the range was from 0.3 to 12.9 pCi/g. The highest average alpha activity was noted at the station with the highest sediment radium concentration, indicating a relation betwen water radioactivity and suspendable particulate content that was substantiated by the low levels in both water and sediment at many of the other stations.

EPA has promulgated drinking water standards for combined radium-226 and radium-228, and gross alpha particle radioactivity at 40 CFR 141.16. The standards are 5 pCi/l and 15 pCi/l, respectively. In the case of the gross alpha particle standard, radiation from uranium and radon are specifically excluded from the standard. It can be seen from reviewing the surface water data in Tables 5-8 through 5-11 that the gross alpha standard was easily met by all samples. In the case of the single sample that exceeded the radium standard of 5 pCi/l, it was demonstrated that suspended sediment contributed the majority of the radium. This sediment would be removed by the typical treatment system for a community surface water supply, thus assuring compliance with the EPA Standard.

5.1.2.6 Groundwater

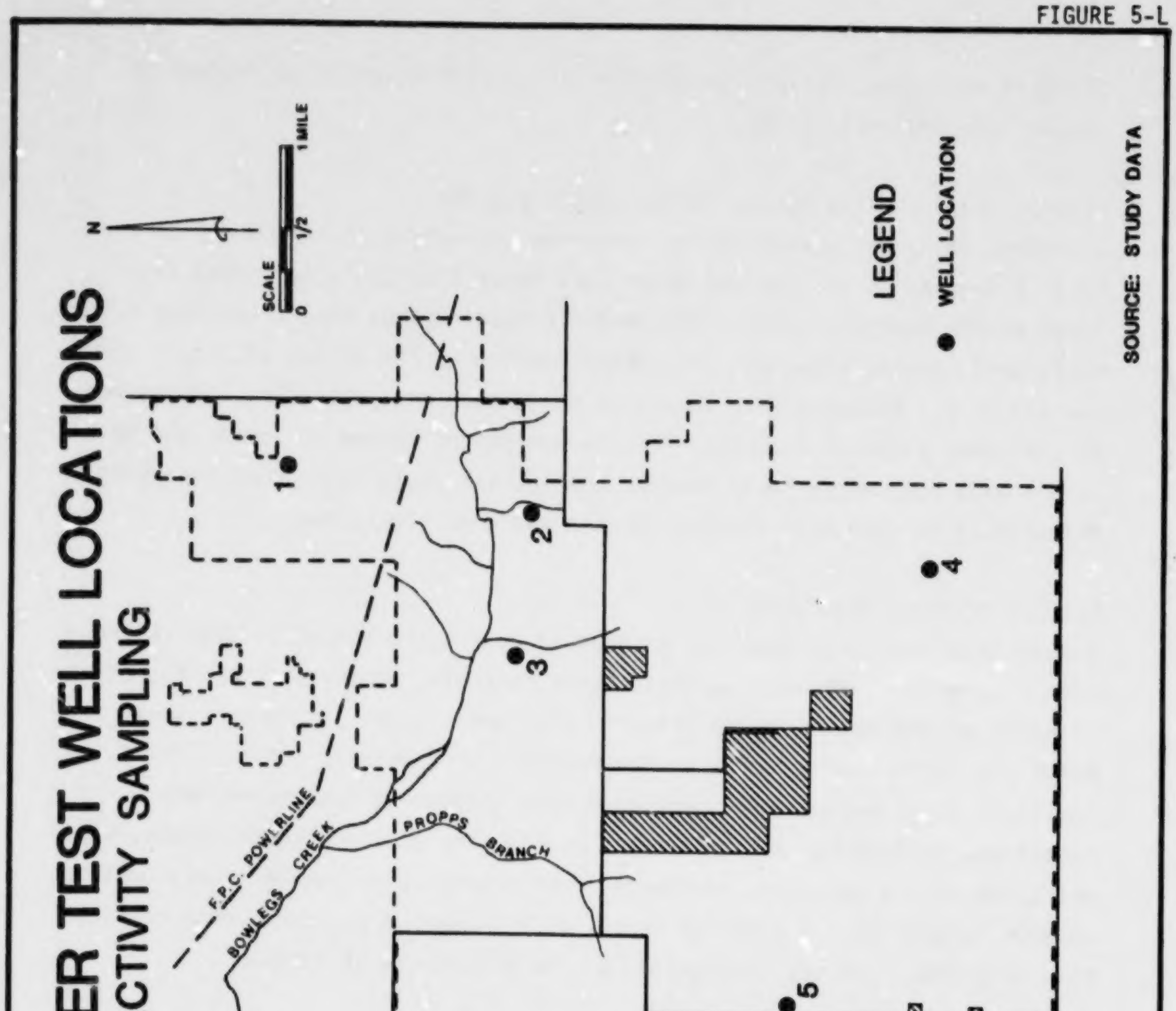
The drinking water standards promulgated by EPA in final form July 9, 1976 at 40 CFR 141.15 apply to groundwater as well as surface water. These standards specify a combined radium-226 and radium-228 maximum concentration of 5 pCi/l and a gross alpha particle radioactivity (including radium-226 but excluding radon and uranium) concentration of 15 pCi/l.

Groundwater samples were collected during the early part of 1980 and again during the fall of 1980 to determine background radioactivity concentrations at the South Fort Meade site. Sampling locations are shown on Figure 5-L. The concentrations of gross alpha radioactivity and radium-226 for the groundwater samples are presented in Table 5-12. Radium-226 concentrations were determined only for those samples where gross alpha radioactivity approached 5 pCi/l.

Groundwater radioactivity concentrations in the Surficial Aquifer at the South Fort Meade site were extremely variable; gross alpha radioactivity levels ranged from less than 0.4 pCi/l to 97.4 pCi/l. For those samples where radium-226 was detected concentrations ranged from 1.1 to 14.6 pCi/l. The highest radioactivity concentrations occurred in samples with high total solids concentrations, as shown in Table 5-12. It is likely that the high radioactivity concentrations in the Surficial Aquifer groundwater are due to high suspended solids concentrations. Surface water radioactivity discussed in the previous section also indicated higher radioactivity when higher concentrations of suspended particles were present. Three groundwater samples exceeded the 15 pCi/l gross alpha radioactivity standard for drinking water, and two exceeded the radium-226 standard of 5 pCi/l. It is unlikely, however, that the Surficial Aquifer at the South Fort Meade site would ever be used as a drinking water source.

Groundwater samples from the Upper Floridan and Lower Floridan Aquifers exhibited gross alpha radioactivity levels of 48.4 plus or minus 18.1 and 34.3 plus or minus 8.6 pCi/l, respectively. Although these values exceed the drinking water standard of 15 pCi/l, the radium-226 concentrations of 4.4 plus or minus 0.3 and 2.3 plus or minus 0.1 pCi/l for the same samples are typical

FIGURE 5-L



GROUNDWATER TEST WELL LOCATIONS
RADIOACTIVITY SAMPLING

SOURCE: STUDY DATA

of Upper and Lower Floridan groundwater in unmined mineralized regions of central Florida (EPA, 1978).

5.1.2.7 Radionuclide Uptake in Biological Systems

A limited study was undertaken to determine the uptake of radium-226 by biological samples at the unmined South Fort Meade site and a reclaimed site known as the Homeland tract. Radium-226 concentrations were determined for beef, soil, grass, vegetable and citrus samples by the method of direct gamma spectrometry. Radioactivity levels in the tissue and vegetation samples were at the lower limit of detection for the analytical method employed, and have such a wide confidence level that no conclusions could be reached regarding differences between pre- and post-mining radionuclide uptake.

5.1.2.8 Quality Assurance

A quality assurance program was maintained during the radiation data collection program that included administrative controls, personnel training, establishment of procedures, calibration of instruments, quality control measurements and corrective action when measurements were outside control limits. Quality control measurements performed were instrument background determinations, performance and efficiency checks, periodic duplicate, blank, blind and spike sample analyses, and participation in a split sample program with an outside laboratory. A detailed report of all quality assurance results is on file with EPA. The key conclusions of the report are as follows:

- Gamma survey meters were checked against a radium disk source in the field before each survey to verify that the instruments were functioning properly.
- The portable scintillation survey meters were intercalibrated against a calibrated pressurized ionization chamber at field locations.
- Results of reference samples, duplicate analyses and split samples for gamma spectrometry indicated that the gamma spectrometry system and calculation techniques were precise and stable.
- The system used for shallow gamma logging was checked daily in the field against a radium disk source at several distances to verify that the system was operating properly on each scale.

- Instrument background was measured and recorded each time a batch of samples were counted with the alpha counter and the instrument counting efficiency was checked periodically. The instrument background fell within the expected range of variations.
- Blank sample analyses of gross alpha indicated that there were no statistically significant differences between the results of the duplicates, thus confirming the reproducibility of the analyses.
- Results of the EPA cross-check program for gross alpha activity indicated that the reported average was within the standard deviation of the expected value and closer to the expected value than the mean of all participating laboratories.
- Radium cross-check samples from EPA indicated that the results from the laboratory were within the control limits for radium.

5.2 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

5.2.1 THE NO ACTION ALTERNATIVE

Under the no action alternative the South Fort Meade site would remain in its current state. Subsurface radioactivity would remain concentrated in the matrix and the leach zone instead of being redistributed to soils nearer the surface. Thus, the expected outdoor gamma radiation levels and the Rn-222 flux would be lower than would be expected to occur after mining and reclamation. Structures, including residences, would have lower indoor concentrations of radon progeny on undisturbed land than on reclaimed land. Occupational radiation exposures resulting from phosphate mining and beneficiation would not occur, and additional exposure to residents near the mining and processing operations (due to inhalation of particulates) would be avoided.

5.2.2 THE ACTION ALTERNATIVES INCLUDING THE PROPOSED ACTION

5.2.2.1 Mining Method Alternatives (See description DEIS 2.2)

Dragline (Mobil's Proposed Action): The use of a dragline to remove overburden and matrix ore would have several potential radiological impacts. Each dragline would dig a series of parallel cuts up to one mile long and approximately 330 feet wide, and the overburden, typically containing low levels of radionuclides (1 to 8 pCi/g), would be placed in a previously mined area. Mobil would practice leach zone management by placing the radioactive leach zone material (3 to 60 pCi/g) in a pocket at the bottom of the mined-out area (pocket toe spoiling), subsequently covering the leach zone material with overburden. This would minimize the impact of redistributing naturally occurring radionuclides during the mining operation and would reduce surface radiation levels on reclaimed landforms.

A moderate amount of dewatering of the mining cut is required for dragline safety and the optimum recovery of matrix. This dewatering is not considered to have a major radiological impact (EPA, 1978). The potential occupational radiation exposure to phosphate miners is low. Prince (1977) measured radiation levels in the vicnity of draglines to be about 5 uR/h (as compared to the average 4.4 uR/h baseline measured at the South Fort Meade site). Radiation standards for exposure to Rn-222 and its short-lived daughters are expressed in terms of working level (WL) concentrations. One WL is the amount of any combination of short-lived radioactive daughters of Rn-222 in 1 liter of air that will release 1.3×10^5 MeV of alpha energy during their decay to Pb-210. Radon progeny concentrations were found to be low (0.0004 WL) in the actively mined areas. In comparison, these exposure levels are far lower than measured values for slab-on-grade structures on unmined land in Polk County (0.001 to 0.032 WL).

Bucket Wheel: Radiological impacts from the use of bucket wheel excavators would be similar to those experienced with the use of draglines. Bucket wheel excavators can be very selective and would be capable of performing leach zone management.

Dredge: The use of dredges to remove the overburden and mine the phosphate ore would have several radiological effects not present with the dragline method. Selective leach zone removal and placement would be impossible to practice using the dredge due to indiscriminate placement of leach zone material in the spoils area. Radiation levels in the reclaimed landforms would thus be greater with this method than with the dragline method. The water used to transport the overburden and leach zone material could increase in radioactivity due to the presence of suspended radioactive particles. These suspended particles would enter the recirculation system and perhaps elevate radiation levels in the waste disposal areas and water discharge.

5.2.2.2 Matrix Processing Alternatives (See description DEIS 2.4)

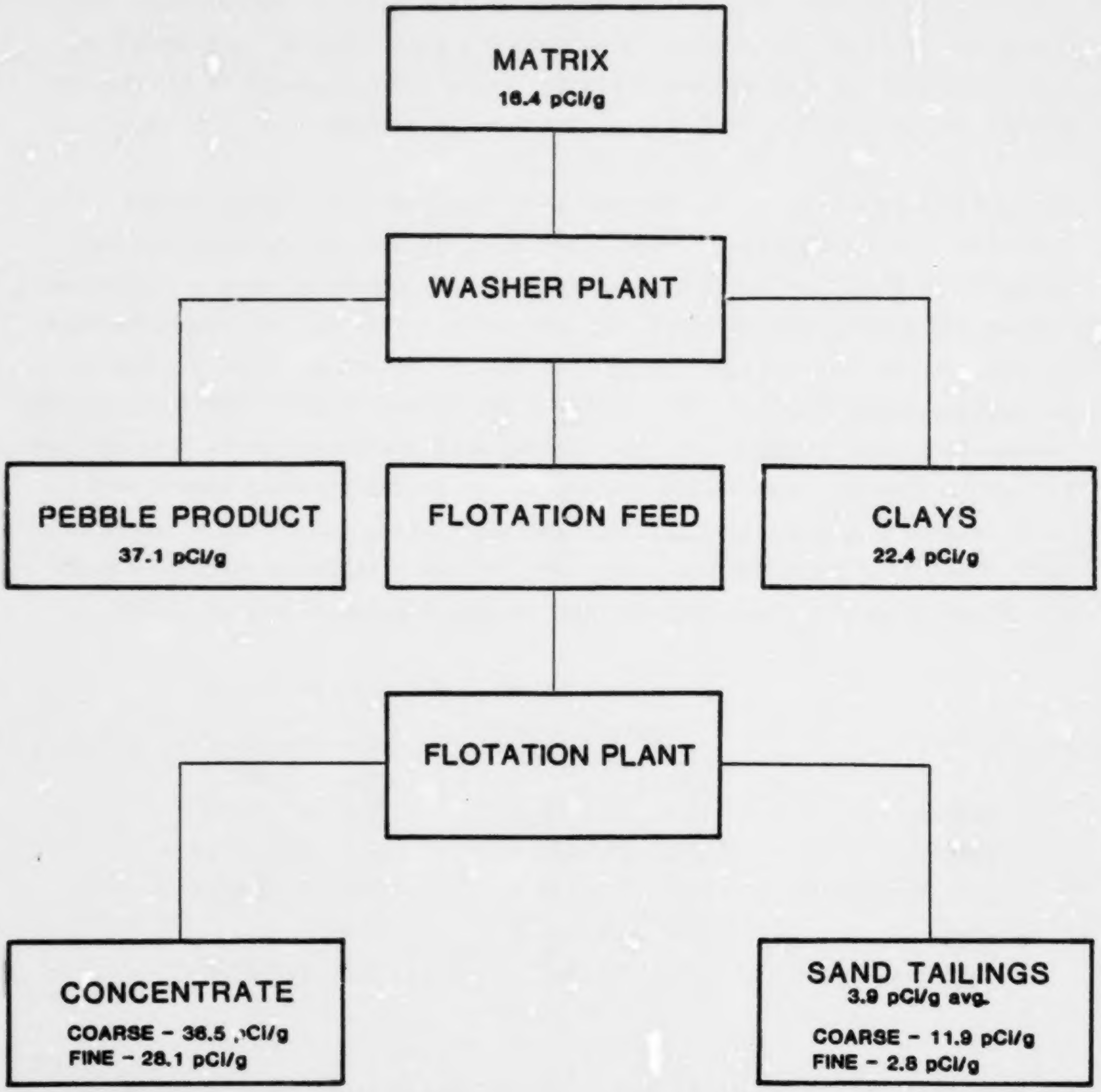
Conventional Beneficiation (Mobil's Proposed Action): Conventional processing of slurried matrix would redistribute naturally occurring radionuclides between products and wastes. Pilot scale beneficiation of South Fort Meade matrix was performed to examine this redistribution. As shown in Figure 5-M, slurried matrix contained an average of 16.4 pCi/g of radium-226. The slurry was processed in a washer plant where a pebble product was separated from the flotation feed and waste clays. Projected radium-226 in the pebble product was 37.1 pCi/g; waste clays contained an average of 22.4 pCi/g.

The coarse feed was processed further in a flotation plant where it was separated into a concentrate product averaging 36.5 pCi/g and sand tailings averaging 11.9 pCi/g. The fine feed fraction was separated into a concentrate product (28.1 pC/g) and sand tailings stream (2.8 pCi/g). The composite sand tailings stream contained an average radium-226 concentration of 3.9 pCi/g. The radioactivity levels of the fractions determined in the pilot-scale beneficiation test were variable, as shown below, with the exception of the level of the pebble product. Radium-226 concentrations in the proposed mine's phosphate matrix, products, sand tailings and waste clays appear to be somewhat lower than the average for the area. The following table compares the South Fort Meade values to those reported for central Florida (Roessler, 1979).

	South Fort Meade (pCi/g)		Central Florida (pCi/g)	
	Avg.	Range	Avg.	Range
Matrix	16.4	10.7-22.1	37.6	18.1-184.2
Pebble	37.1	35.1-39.4	57.4	44.5-96.6
Rock Concentrate	32.3	22.7-43.3	37.1	26.0-50.7
Clay	22.4	12.1-45.4	52.0	-
Sand tailings	3.9	1.7-10.3	5.2	1.7-12.2

Wet processing of the slurried matrix during conventional beneficiation has little potential for the generation of airborne radioactivity associated with

SCHEMATIC DIAGRAM OF BENEFICIATION AND ASSOCIATED RADON-226 LEVELS FROM PILOT PLANT TESTS



SOURCE: MOBIL

particulates. Radiological exposure due to the release of particulate material during processing is considered negligible.

The external gamma radiation levels in beneficiation plants have been reported to be about twice the background levels (Prince, 1977). However, results of a work-station survey found occupancy factors low enough to reduce annual exposures to insignificant levels. Radon progeny concentrations were below the levels reported for slab-on-grade structures on unmined land (0.0007 WL). Therefore, the radiological impacts to operating personnel at the plant should be minimal.

Wet rock storage piles have been reported to yield gamma radiation at an average rate of 67 uR/h (Prince, 1977). However, occupancy factors around such piles are extremely small, making the annual exposure to an individual insignificant. Wet rock storage and transfer tunnels (located under wet rock piles) were found to be the most serious radiological hazard areas. WL measurements at 11 sites in the Central Florida Phosphate District were between 0.0007 WL and 0.096 WL. (Prince, 1977).

Dry Separation: The dry separation process would have the potential for generating large amounts of clay- and dust-size particulates which could lead to exposure to radiation through inhalation. Greater exposure to radiation would be expected from the use of the dry-separation process than from the conventional beneficiation process.

5.2.2.3 Waste Disposal and Reclamation Alternatives (See description DEIS 2.5 and 2.6)

Conventional Clay Settling Plan (Mobil's Proposed Action): The two major types of wastes requiring disposal would be clay and sand tailings. As was discussed in the section on processing, waste clays at the South Fort Meade site have a much higher average radium-226 level (22.4 pCi/g) than the sand tailings (3.9 pCi/g). The method of disposal and land reclamation would determine future surface radium-226 concentrations. Table 5-13 presents the acreages associated with each reclaimed land type and the estimated radiological characteristics for the conventional clay settling case. The soil radium-226 levels shown are for the top two feet of reclaimed land. Gamma radiation levels were estimated by the method in Report No. 45 of the National Council on Radiation Protection and Measurements (NCRPM, 1975). No average gamma radiation level was determined for the below-grade clay settling areas since the level is dependent on the amount of water present. Submerged clay settling areas are expected to exhibit little or no gamma radiation due to the attenuation of water. Pocket toe spoiling would prevent the leach zone material from affecting the surface radiation levels.

A major problem discussed in the Areawide EIS is the potential hazard of exposure to indoor radon progeny measured as WL within slab-on-grade residential and public structures. Should buildings be located on the reclaimed site, indoor radon and radon progeny concentrations would be higher in these structures than outdoors. Two WL standards have been proposed for existing homes: (1) a 0.029 WL total exposure including background (Florida Department of Health and Rehabilitation Services 1978) and, (2) a 0.020 WL total exposure including background (EPA, 1979). The reclamation processes and undeveloped lands were not addressed in detail in EPA's 1979 recommendations to the Governor of Florida (EPA, 1979). However, the following specific guidance was provided for new homes on any reclaimed, debris and unmined lands which contain phosphate resources:

> "IV. Development sites for new residences should be selected and prepared, and the residences so designed and sited, that the annual average indoor... Working Levels...do not exceed...background levels..." (EPA, 1979).

If the final guidance for reclaimed lands is similar to the recommendation quoted above, then the upper limit of predicted WL's in slab-on-grade homes will be approximately 0.009 WL (normal background of 0.004 WL plus the uncertainty of 0.005 WL). This proposed limit provides a basis for assessing the effectiveness of reclamation in minimizing indoor exposures to radon progeny. For any homes that are constructed on reclaimed lands at the South Fort Meade site, the predicted indoor radon progeny concentrations could range from a low of 0.0068 WL over overburden fill areas (477 acres) to 0.0172 WL over the 8,194 acres of reclaimed clay settling areas. The predicted radon progeny concentrations for homes over the 1,489 acres of clay settling areas with sand cap would be 0.0121 WL, and homes over the sand tailings fill areas with overburden cap (5,034 acres) would be 0.0082 WL. By way of comparison, slab-on-grade structures in Polk County over undisturbed lands have WL's ranging from 0.001 to 0.010, with a geometric mean of 0.003. Residences on the reclaimed overburden fill areas (477 acres) or sand tailings capped with overburden areas (5,034 acres) would have predicted indoor radon progeny marginally below the EPA recommended 0.009 WL limit described above. If residences were planned in other reclaimed areas, they would have to be designed so as to prevent the accumulation of radon progeny to levels above the recommended .009 WL limit.

There is also an interim EPA recommendation (41 CFR 123, June 24, 1976) to limit gamma exposure levels at new structure sites on Florida phosphate lands to 10 uR/h. Given the current degree of uncertainty as to what constitutes a "no-effects" level of radiation on reclaimed phosphate lands, it is informative to compare the various reclamation alternatives considering these proposed criteria. As shown in Table 5-13, the predicted gamma radiation levels for all land types except above-grade clay settling areas (44 uR/h) and below-grade clay settling areas covered with water (4 to 85 uR/h depending upon the amount of attenuation by water) meet the interim EPA recommendation for a gamma exposure level limit of 10 uR/h. The above-grade clay settling areas, constituting 6,681 acres or about 44 percent of the reclaimed lands, are considerably above the interim recommended gamma level and thus, no structures could be constructed thereon without use of some type of mitigating measures to lower the exposure levels. For the 1,513 acres of below-grade clay settling areas, the water could be expected to attenuate much of the gamma radiation, although if the area were to completely dry out, the gamma radiation could approach the level of the above-grade clay settling area. The 1,489 acres of above-grade clay capped with sand tailings would have an estimated gamma radiation level of 9 uR/hr, marginally below the interim EPA recommendation of 10 uR/hr. Overburden fill areas, comprising 477 acres, and 5,034 acres of sand tailings capped with overburden would be well below the 10 uR/hr limit.

Radionuclide uptake by crops and subsequent passage through the food chain is another area of concern on reclaimed lands. Radionuclide uptake in crops apparently is a function of soil characteristics, crop type, calcium concentration and soil radium-226 concentration. Mobil's reclamation plan calls for the return of much of the site to agricultural usage. There is no evidence that agricultural development of the reclaimed mine site would pose a significant radiological hazard through soil-to-crop-to-man food chain uptake. However, little is known about the behavior of Ra-226 uptake from this type of soil. It should be noted that current fertilizer products may contain Ra-226 up to 32 pCi/g. Thus, direct application of fertilizer products to crops may be of more concern than the direct radionuclide uptake from reclaimed soils.

Surface soil radium-226 concentrations at 16 locations on the South Fort Meade site ranged from 0.2 to 1.1 pCi/g with an average of 0.4 pCi/g. The waste disposal and reclamation process will redistribute radioactive materials in the soil profile, resulting in increased surface soil radium-226 concentrations. As shown in Table 5-13, surface soil radium-226 levels for reclaimed lands are expected to range from 1 pCi/g for the 477 acres of overburden fill areas to 22 pCi/g for the 6,681 acres of above-grade clay settling areas and 1,513 acres of below-grade clay settling areas. Estimated radium-226 concentrations for the 5,034 acres of sand tailings capped with overburden and 1,489 acres of above-grade clay capped with sand tailings are 3 pCi/g.

Radon flux from waste disposal materials is another concern for reclaimed landforms. The radon flux indicates the potential hazard associated with construction of slab-on-grade residential and public structures on reclaimed lands, and correlates to the indoor radon progeny measured as WL. Radon flux measurements on unaltered lands in Polk County range from <0.1 to 1.1 pCi/m^2/sec with an average of 0.2 pCi/m^2/sec (Roessler, 1978). The radon fluxes shown in Table 5-13 for each reclaimed landform were calculated from a bi-layer diffusion model, using parameters taken from the data of Roessler et al. (1978) for similar media. It is estimated that the process of land reclamation would increase the radon flux of the unaltered land to a range of 0.59 pCi/m^2/sec (for the 477 acres of overburden fill) to 4.38 pCi/m^2/sec (for the 6,681 acres of above-grade clay settling area and 1,513 acres of below-grade clay settling areas). Radon flux from the 5,034 acres of sand tailings capped with overburden is projected to be 0.87 pCi/m^2/sec, and 2.05 pCi/m^2/sec from the 1,489 acres of above-grade clay capped with sand tailings.

Decant water from the clay settling ponds would be recycled through the water recirculation system. The typical concentration of radium-226 in water released from clay settling areas is 1 to 2 pCi/l, which is less than the allowable concentration of 5 pCi/l in drinking water. Release of this water should have a minimal impact on the radiological characteristics of surface water supplies (EPA, 1978).

Groundwater radiation levels are not expected to increase as a result of reclamation. Groundwater in the Surficial Aquifer would be in contact with OPbasically the same material present before mining. Moreover, some of the radioactivity initially present would remain with the product, reducing the total amount of radionuclides left in the soil.

Surface water quality is not expected to be degraded by land reclamation. Radium-226 is not very soluble (2×10^{-6} g/100 ml as radium sulfate) and is found in low concentrations (0.67 pCi/l) even in clay pond effluents, which are in contact with clays containing relatively high levels of radium-226 (22.4 pCi/g). Since waste clay settling areas would have the highest radium-226 levels of all reclaimed lands, radiological impacts of reclamation on surface water are expected to be minimal.

Sand/Clay Cap Plan: The sand/clay cap reclamation plan would result in five basic landforms: above-grade clay settling areas with sand/clay mix (4:1) cap (7,580 acres), sand tailings fill areas with overburden cap (5,079 acres), below-grade clay settling areas with partial overburden cap (1,513 acres), above-grade clay settling areas with overburden cap (590 acres) and overburden fill areas (432 acres). Under the sand/clay cap alternative, the predicted exposure levels for radon progeny would range from a low of 0.0068 WL for the 432 acres of overburden fill area to 0.0172 WL for the 1,513 acres of below-grade clay settling areas (Table 5-14). However, it is extremely unlikely that residential structures would be built in the below-grade clay settling areas because they would be reclaimed as wetlands. The 7,580 acres of clay settling areas capped with a 4:1 sand/clay mix would produce an estimated radon progeny level of 0.0126 WL, and structures built on such lands would require measures to reduce the indoor radon progeny to below the recommended

0.009 WL limit. A total of 5,511 acres, comprised of 5,079 acres of sand tailings capped with overburden and 432 acres of overburden fill, would meet the recommended 0.009 WL limit with 0.0082 WL and 0.0068 WL, respectively (although marginally in the case of the sand tailings areas capped with overburden). Approximately the same amount of acreage is also below the recommended 0.009 WL limit for the conventional plan.

The sand/clay cap plan would result in a total of 9,683 acres of reclaimed land potentially exceeding the interim gamma radiation exposure level of 10 uR/hr, or a total of 1,479 more acres than occurs with the conventional plan. The area of sand tailings capped with overburden, with an estimated gamma radiation of 5 uR/hr, would increase slightly from 5,034 acres under the conventional plan to 5,079 acres. The overburden fill area (5 uR/hr) would decrease slightly from 477 to 432 acres. The significant difference between the two cases is that the 7,580 acres of clay settling areas capped with a 4:1 sand/clay mix would have an estimated gamma radiation level of 18 uR/hr (ranging from 14 to 25 uR/hr) as compared to the 6,681 acres of uncapped clay fill in the conventional case having an estimated gamma radiation level of 44 uR/hr (ranging from 25 to 85 uR/hr). The 1,513 acres of below-grade clay settling areas would have a projected gamma radiation level ranging from 4 to 85 uR/hr depending on the amount of attenuation by water. Higher water levels in the wetland area would tend to reduce the gamma radiation levels. Only the 590 acres of clay areas capped with overburden with a projected gamma exposure rate of 38 uR/hr approach the 44 uR/hr exposure rate for above-grade clay settling areas for the conventional plan. Thus, the sand/clay cap alternative would reduce gamma exposure as compared to the conventional case.

Soil radium-226 concentrations (Table 5-14) are expected to range from 1 pCi/g for the 432 acres of overburden fill to 22 pCi/g for the 1,513 acres of below-grade clay settling areas. A total of 5,079 acres of sand tailings capped with overburden would have an estimated soil radium-226 concentration of 3 pCi/g. The major difference between this alternative and the conventional plan is that the large area of clay capped with a 4:1 sand/clay mix (7,580 acres) would have an estimated soil radium-226 concentration of 10 pCi/g, whereas the conventional plan would have 6,681 acres of above-grade clay settling areas at 22 pCi/g. Since surface radium-226 concentrations are generally reduced, radionuclide uptake by crops would probably be less for the clay settling areas covered with sand/clay mix (10 pCi/g) than the clay settling areas under the conventional plan (22 pCi/g).

The predicted radon fluxes are less for the sand/clay cap plan than for the conventional plan, with a range of 0.59 pCi/m^2/sec for the 432 acres of overburden fill to 4.38 pCi/m^2/sec for the 1,513 acres of below-grade clay settling, as shown in Table 5-14. The 5,079 acres of sand tailings capped with overburden and the 590 acres of above-grade clay settling areas would have projected radon fluxes of 0.87 and 3.67 pCi/m^2/sec, respectively. The largest reclaimed landform, the clay settling areas capped with a 4:1 sand clay mix, would have an estimated radon flux of 2.25 pCi/m^2/sec, significantly smaller than the 4.38 pCi/m^2/sec projected for the 6,681 acres of above-grade clay settling areas under the conventional plan.

The radiological effects of the sand/clay cap plan on surface water and groundwater would be, for all practical purposes, identical to the conventional clay settling plan, and are expected to be minimal.

Sand/Clay Mix Plan: The sand/clay mix plan would result in six basic reclaimed landforms: sand/clay mix (3,512 acres), clay settling areas with sand/clay mix cap (3,185 acres), sand tailings fill areas with overburden cap (3,020 acres), below-grade clay settling areas (2,095 acres), overburden fill areas (1,740 acres) and uncapped above-grade clay settling areas (1,642 acres). If the sand/clay mix plan were adopted, the exposure levels for radon progeny as measured by WL would generally be lower than the conventional clay settling plan but above the sand/clay cap plan. As shown in Table 5-15, a total of 3,737 acres would have the highest estimated indoor radon progeny level of 0.0172 WL, including 1,642 acres of above-grade clay settling areas and 2,095 acres of below-grade clay settling areas. The below-grade settling areas would be wetlands and since these lands will be subject to frequent inundations, it is unlikely that they will be utilized for the construction of residential or public buildings. Other significant reclaimed landforms which will be above the 0.009 WL limit include 3,512 acres of 2:1 sand/clay mix at 0.00112 WL and 3,185 acres of clay capped with the sand/clay mix at 0.0125 WL. A total of 4,760 acres would be below the interim recommended limit of 0.009

WL: 3,020 acres of sand tailings capped with overburden at 0.0082 WL and 1,740 acres of overburden fill at 0.0068 WL. This acreage is less than with either the conventional clay settling or sand/clay cap alternatives.

The sand/clay mix plan results in a total of 10,434 acres of reclaimed lands which would exceed the interim gamma exposure limit of 10 uR/h. Thus, substantially more acreage exceeds this limit under the sand/clay mix plan than occurs with the proposed action (6,681 acres). It must be recognized, however, that the area of land with the highest gamma radiation levels (44 uR/h) is 6,681 acres in the conventional plan and only 1,642 acres (above-grade clay settling areas) for the sand/clay mix reclamation approach. Potential radiation exposure to the general public is thus lower for the sand/clay mix plan than for the conventional reclamation plan. The projected gamma radiation on 3,512 acres of 2:1 sand/clay mix (22 uR/hr) and 3,185 acres of clay capped with the sand/clay mix (25 uR/hr) is substantially greater than the interim exposure limit of 10 uR/hr. However, 1,740 acres of overburden fill (5 uR/hr) and 3,020 acres of sand tailings capped with overburden (5 uR/hr) are well within the recommended limit. The 2,095 acres of below-grade clay settling areas have an estimated gamma radiation level with a range of 4 to 85 uR/hr, depending on the depth of water present to attenuate gamma radiation.

With the sand/clay mix plan, a mixture of two-parts sand to one-part clay would be used to reduce the amount of conventional clay settling areas. As shown in Table 5-15, the 3,512 acres of sand/clay mix (10 pCi/g) and 3,185 acres of clay capped with sand/clay mix (12 pCi/g) would have predicted radium-226 concentrations significantly less than the 22 pCi/g for conventional clay settling areas. With the sand/clay mix alternative, the area used for conventional clay settling would be reduced to 1,642 acres from 6,681 acres under the proposed action. The below-grade clay settling areas would have an estimated soil radium-226 concentration of 22 pCi/g, and would be increased from 1,513 acres under the conventional plan to 2,095 acres. The lowest soil radium-226 concentrations under the sand/clay mix alternative would be an estimated 1 pCi/g for the 1,740 acres of overburden fill and 3 pCi/g for the 3,020 acres of sand tailings capped with overburden.

Agricultural use of reclaimed lands under the sand/clay mix plan would result in a lower potential for radium-226 uptake by crops since the uncapped clay settling areas with the highest level of radium-226 (44 pCi/g) total far fewer acres than in the conventional plan (1,642 acres versus 6,681 acres).

Overall, the estimated radon fluxes would be less for the sand/clay mix case than for the conventional case. The highest estimated radon flux, 4.38 pCi/m^2/sec, would occur on 1,642 acres of above-grade clay settling areas and 2,095 acres of below-grade clay settling areas. Much of the 6,681 acres of above-grade clay settling areas (4.38 pCi/m^2/sec) in the conventional plan would be replaced with 3,512 acres of sand/clay mix (1.71 pCi/m^2/sec) or the 3,185 acres of clay capped with sand/clay mix (2.20 pCi/m^2/sec). Although the area of overburden fill (0.59 pCi/m^2/sec) would be increased from 477 acres to 1,740 acres from the conventional plan, the amount of sand tailings areas capped with overburden (0.87 pCi/m^2/sec) would be decreased substantially, from 5,079 to 3,020 acres.

Overburden Mix Plan: Five land types would result from waste disposal and reclamation with this alternative: sand tailings capped with overburden (3,020 acres), overburden fill areas (1,740 acres), below-grade clay settling areas (2,095 acres), above-grade clay settling areas with sand/clay mix (2:1) cap (2,847 acres), and sand/clay mix (2:1) lands (5,492 acres).

Based on a maximum indoor radon progeny of 0.009 WL, a total of 4,760 acres of reclaimed land under this plan would be suitable for the construction of residences and public buildings (Table 5-16). This acreage includes 3,020 acres of sand tailings capped with overburden (0.0082 WL) and 1,740 acres of overburden fill (0.0068 WL). On the 5,492 acres of overburden sand/clay mix areas and on the 2849 acres of, the projected indoor radon progeny are 0.0126 WL, and 0.0125 WL, respectively, which means that mitigation measures would be required to allow construction. From this standpoint, the overburden mix case offers no advantage over the proposed action. The below-grade clay settling area of 2,095 acres has an estimated radon progeny of 0.0172 WL, which is high. It is unlikely that construction will be desirable in an area frequently inundated with water.

Under the overburden mix alternative, a total of 4,760 acres are expected to exhibit gamma radiation levels well below the 10 uR/hr interim limit. This area, comprised of 3,020 acres of sand tailings capped with overburden and 1,740 acres of overburden fill (both with an estimated gamma radiation level of 5 uR/hr), is smaller than the conventional case, where 7,000 acres are below the interim limit. The 2,095 acres of below-grade clay settling areas (4 to 85 uR/hr) could be expected to meet the interim limit when water levels sufficient to attenuate the gamma radiation are present. At times when water levels are low, this limit could be exceeded. The 5,492 acres of overburden sand/clay mix would have an estimated level of 18 uR/hr, well above the interim limit. The 2,847 acres of clay settling areas with sand/clay mix cap would have an estimated level of 22 uR/hr, also well above the interim limit. The major difference between this alternative and the conventional clay settling case is the absence of above-grade conventional clay settling areas with their associated higher radiation levels. Thus, no areas under this plan would have gamma radiation levels as high as the 44 uR/hr of conventional clay settling areas, with the possible exception of the below-grade clay settling areas if they were to dry out.

With respect to agricultural use, the overburden mix case results in significantly lower soil radium-226 levels than conventional reclamation, reducing the potential for crop uptake of radium-226. As discussed earlier, however, studies by Mobil showed no significant radium-226 uptake on reclaimed lands with relatively high soil concentrations of this radionuclide. Soil radium-226 concentrations would range from an estimated 1 pCi/g for the 1,740 acres of overburden fill to 22 pCi/g for the 2,095 acres of below-grade clay settling areas. The 3,020 acres of sand tailings capped with overburden would have an estimated radium-226 value of 3 pCi/g. The overall radium-226 levels in the reclaimed lands for this case would generally be lower than for the proposed action.

On the average, radon fluxes would be lower for the overburden mix plan than the conventional plan. The 3,020 acres of sand tailings capped with overburden ($0.87\ pCi/m^2/sec$), the 1,740 acres of overburden fill ($0.59\ pCi/m^2/sec$), and the 2,095 acres of below-grade clay settling areas ($4.38\ pCi/m^2/sec$) are comparable to the conventional plan. However, the 6,681 acres of above-grade clay settling areas (4.38 pCi/m2/sec) and the 1,489 acres of above-grade clay capped with sand tailings ($2.05\ pCi/m^2/sec$) have been replaced by the

5,492 acres of overburden sand/clay mix (2.00 pCi/m2/sec) and 2,847 acres of clay settling areas with sand/clay mix cap (2.2 pCi/m^2/sec), an improvement over the conventional plan.

The radiological effects of the overburden mix case on groundwater and surface water are, for all practical purposes, identical to the proposed action.

5.2.2.4 Product Transport Alternatives (See description DEIS 2.10)

Railroad (Mobil's Proposed Action): Radiological effects due to product transport should be minor. For transport by railroad, dust generation and spillage would be transient effects. Accidental spillage could occur but would be cleaned up and would not pose a significant radiological impact.

Truck: The use of trucks for transport would not have radiological effects significantly different from the use of railroad cars.

5.3 REFERENCES

Guimond, R.J., W.H. Ellett, J.E. Fitzgerald, S.T. Windham and P.A. Cuny, 1979. Indoor Radiation Exposure Due to Radium-226 in Florida Phosphate Lands, prepared by Criteria and Standards Division, Office of Radiation Programs, U.S. Environmental Protection Agency.

Prince, Robert J., 1977. " Occupational Radiation Exposure in the Florida Phosphate Industry," M.S. Thesis, University of Florida.

Roessler, C.E. R. Kautz. W. E. Bolch, Jr. and J.A. Wethington, Jr. 1978. The Effect of Mining and Land Reclamation on the Radiological Characteristics of the Terrestrial Environment of Florida's Phosphate Regions, The Natural Radiation Environment III Symposium, Houston, Texas.

Roessler, C.E., Z.A. Smith, W.E. Bolch and R.J. Prince, 1979. Uranium and Radium-266 in Florida Phosphate Materials Health Phys Vol. 37:269-277.

The National Radiation Environment, Appendix 4, 1964. University of Chicago Press.

U.S. Environmental Protection Agency, 1978. Final Areawide Environmental Impact Statement, Central Florida Phosphate Industry.

U.S. Environmental Protection Agency, 1979. Recommendations for Radiation Protection of Persons Residing on Phosphate Land, Letter from Douglas M. Costle, EPA Administrator, to the Governor of Florida, May 30, 1979.

TABLE 5-1

SUMMARY OF ^{226}Ra AND ^{238}U ANALYSES OF PHOSPHATE MATERIALS - CENTRAL FLORIDA

Sample Type	No. Samples	^{226}Ra, pCi/g Average (Range)	^{238}U, pCi/g Average (Range)	Ratio, Ra/U Average (Range)
Mining and Rock Operations:				
Matrix	6	37.6 (18.1-1-84.2)	38.5 (20.2-83.4)	0.97 (0.82-1.06)
Pebble	13	57.4 (44.5-96.6)	45.8 (36.0-68.1)	1.26 (1.03-1.43)
Rock Concentrate	22	37.1 (26.0-50.7)	31.9 (20.1-49.8)	1.18 (0.97-1.42)
Clays:				
Old settled areas	10	23.8 (12.6-43.0)	27.1 (16.0-49.2)	0.87 (0.72-1.02)
From plant	1	52.0	--	--
Tailings	24	5.2 (1.7-12.2)	4.7 (1.5-10.4)	1.11 (0.83-1.44)
Phosphoric Acid Plant:				
5% Phosphoric Acid	1	0.1	6.3	0.01
15% Phosphoric Acid	1	0.2	17.1	0.01
30% Phosphoric Acid	1	0.4	30.0	0.01
Cypsum	10	25.9 (21.1-34.8)	<0.5 (<0.4-<0.7)	>74.69 (>37.69->82.37)
Filtrate Tank Scale	1	384.8	28.1	13.69
Tank Sediment	2	74.4 (64.6-84.1)	<0.7 (<0.4-<1.0)	>127.05 (>84.10->170.0)
Fertilizer:				
Ammoniated Phosphates (MAP & DAP)	8	4.1 (1.4-12.1)	70.2 (46.0-81.8)	0.06 (0.02-0.15)
Triple Superphosphate (TSP-ROP & GTSP)	10	19.7 (15.2-32.0)	56.5 (40.1-72.7)	0.36
Electric Furnance:				
Coke	1	1.0	1.7	0.59
Slag	4	61.1 (51.6-66.0)	61.1 (48.6-70.9)	1.00 (0.93-1.06)
Ferro-Phos	1	1.9	40.9	0.05

SOURCE: ROESSLER, 1979

TABLE 5-2

SUMMARY OF RADIOLOGICAL CHARACTERISTICS OF VARIOUS LAND TYPES - POLK COUNTY

	Surface Soil (0-0.3m) ^{226}Ra (pCi/g)		Soil Core (0-1.8m) ^{226}Ra (pCi/g)		Gamma Level (μR/h)		Radon Flux (pCi/m^2.s)	
Land Type	N	Mean (range	N	Mean (range)	N	Mean (range)	N	Mean (range)
Unaltered	20	0.6(0.1-3.8)	18	0.4(0.2-3.1)	9	5(4-7)	17	0.2(<0.1-1.7)
Unmined	2	3.2(2.5-4.1)	2	2.2(1.1-4.4)	1	9 ---	2	1.3(0.6-2.8)
Radioactive Fill								
Tailings	20	3.2(0.4-9.2)	16	3.1(0.5-8.7)	11	11(6-16)	19	0.7(<0.1-2.7)
All Overburden$^{a)}$	23	5.0(0.8-35.3)	24	5.3(1.0-23.1)	16	13(7-33)	27	1.5(<0.1-12.8)
Capped and Mixed Clays$^{b)}$	6	6.8(3.3-14.6)	6	7.4(2.8-18.3)	6	17(11-24)	6	1.6(0.3-7.2)
Debris	18	9.5(3.4-23.3)	18	7.3(3.1-24.7)	8	22(11-54)	15	4.2(1.7-13.7)

N = Number of sites in summary

Means are geometric means of average values for N sites of indicated land type

a) Overburden category includes reclaimed overburden piles and sand-fill reclamations capped with overburden

b) Clay category includes settled clays areas capped with overburden and/or tailings and clay-sand mixtures capped with overburden

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SOURCE: ROESSLER, 1978

TABLE 5-3

GAMMA SURVEY SUMMARY BY SECTION

Section [(a)]	N[(b)]	Exposure Rate (μR/hr) Avg. (Range
T32S, R25E 13	10	4.2 (4.1 - 4.8)
14	9	4.2 (4.0 - 4.8)
15	5	5.5 (4.8 - 6.2)
22	11	4.1 (3.5 - 4.8)
23	17	5.1 (4.4 - 6.2)
24	7	4.6 (4.4 - 5.1)
25	3	3.8 (3.5 - 4.0)
35	13	5.6 (4.8 - 6.5)
36	10	3.9 (3.1 - 4.4)
T32S, R26E 10	8	5.0 (4.8 - 5.5)
14	5	5.4 (4.8 - 6.2)
15	11	4.5 (4.1 - 4.8)
16	8	4.7 (4.1 - 5.7)
17	17	5.8 (5.1 - 6.1)
18	28	4.4 (3.8 - 4.8)
19	11	4.1 (3.1 - 4.4)
20	19	4.0 (3.1 - 4.4)
21	22	4.8 (3.8 - 5.2)
22	11	4.3 (4.1 - 4.8)
27	10	4.0 (3.4 - 4-1)
28	24	3.7 (3.1 - 5.2)
29	8	4.5 (4.1 - 4.8)
30	25	3.6 (3.1 - 4.8)
31	18	4.1 (3.5 - 4.8)
32	6	4.8 (4.4 - 5.1)
33	7	4.5 (4.4 - 5.1)
34	11	4.0 (3.4 - 4-1)
Summary of 334 Data Points		4.4 (3.1 - 6.5)
Summary of 29 Sections		4.2 (3.6 - 5.8)

(a) Does not include data from 25-yard corridors along roads or the data points that represent departures from the general pattern in the vicinity of streams that cut through the low-radioactivity overburden cover.

(b) N = Number of observations in summary

SOURCE: STUDY DATA

TABLE 5-4

SUMMARY OF RADIUM-226 CONCENTRATIONS IN SURFACE AND NEAR-SURFACE SOIL

	Depth (feet)	N(a)	Radium-226 (pCi/g)	
			Avg.	(Range)
Surface Samples (b)	0-0.5	16	0.4	(0.2-1.1)
Near-Surface Samples (c)	0-1	9	0.3	(0.2-0.4)
	1-2	9	0.3	(0.2-0.3)
	2-3	9	0.3	(0.3-0.6)
	3-4	8	0.4	(0.3-0.8)
	4-5	8	0.6	(0.3-1.0)
	5-6	6	0.6	(0.2-1.0)

(a) N = Number of sampling points

(b) Surface Sample - Consists of either a surface composite, a single sample, or the first 0.5 foot of core taken at well sites.

(c) Shallow core - Values are estimated from gamma probe readings calibrated by a subset of laboratory analyses. Depth of probing was limited in several holes by the water table.

SOURCE: STUDY DATA

TABLE 5-5

SUMMARY OF RADIUM-226 CONCENTRATIONS IN MINED SECTIONS

	Concentration (pCi/g) for Indicated Site						Average and Range (pCi/g)			
							w/Site 10		w/o Site 10	
Profile Portion	5	6	7	9	10	11	Avg.	(Range)	Avg.	(Range)
Surface Soil (a)	0.3	0.3	0.5	0.6	1.1	0.3	0.5	(0.3 - 1.1)	0.4	(0.3 - 0.6)
Overburden Average- Without Leached Zone	3.5	0.7	2.2	1.0	8.4	1.9	3.0	(0.7 - 8.4)	1.9	(0.7 - 3.5)
Leached Zone	60.8	3.1	13.9	(b)	18.9	(b)	24.2	(3.1 - 60.8)	25.9	(3.1 - 60.8)
Overburden Average- With Leached Zone	6.0	1.2	4.0	1.0	10.7	1.9	4.1	(1.0 - 10.7)	2.8	(1.0 - 6.0)
Matrix Composite	14.3	12.0	22.1	20.1	15.9	11.3	16.0	(12.0 -22.1)	16.0	(12.0 - 22.1)

(a) 0 to 0.5 foot

(b) No identified leached zone present

SOURCE: STUDY DATA

TABLE 5-6

RADIUM-226 CONTENT OF MATRIX AND FRACTIONS

				Radium-226 Concentration (pCi/g) for Indicated Fractions					
				+35 Flotation			-35 Flotation		
					Floated			Floated	
Site	Matrix*	Pebble	Clays	Feed	Concentrate	Tailings	Feed	Concentrate	Tailings
5	13.8	39.4	15.9	29.9	36.8	8.7	8.3	29.9	3.5
6	13.7	37.0	12.1	30.7	34.1	11.5	7.4	24.5	3.8
7	21.9	38.0	24.4	27.2	43.3	15.7	10.3	33.9	3.6
9	20.0	35.6	45.5	24.1	36.7	9.5	7.1	27.4	2.1
10	13.1	35.1	14.8	29.2	32.7	19.4	9.4	22.7	1.7
11	15.9	37.2	21.5	28.1	35.6	6.5	7.7	30.2	2.1
Avg.	16.4	37.1	22.4	28.2	36.5	11.9	8.4	28.1	2.8
Range	13.1 - 21.9	35.1 - 39.4	12.1 - 45.4	24.1 - 30.7	32.7 - 43.3	6.5 - 19.4	7.1 - 10.3	22.7 - 33.9	1.7 - 3.8

* Matrix results are the average of two samples per site, one submitted by Mobil and one submitted by Zellars-Williams along with the benefication fractions

SOURCE: STUDY DATA

TABLE 5-7
RADIOACTIVITY OF THE DEEP SECTION

		WATER[a]		CUTTINGS
Well	Depth (Feet)	Gross Activity (pCi/1)	^{226}Ra (pCi/1)	^{226}Ra (pCi/g)
5	600	<1.4	---	0.5
	700	2.7	---	0.6
	800	2.3	---	0.9
	900	5.5	2.4	1.4
	1000	6.0	4.5	1.3
	1100	5.1	---	1.0
	1200	<3.5	---	0.8
6	260-270	4.8	3.9	(c)
	300	<1.0	---	2.8
	400	<1.1	---	1.3
	500	<0.9	<2.1	0.7
	600	<3.1	---	0.5
	700	<1.0	---	0.8
	800	1.7	---	1.0
	900	2.8	2.8	1.3
	1000	<2.9	---	1.7
	1100	<4.1	---	0.8
	1115	6.5	4.1	1.1
	1200	(b)	---	0.8
8	400	2.1	---	1.8
	500	1.6	---	1.4
	600	<1.0	---	0.8
	700	3.3	3.0	1.2
	800	2.7	2.5	0.8
	900	2.7	2.6	1.1
	1000	4.7	2.0	2.3
	1100	<1.1	---	1.3
	1200	<3.5	3.6	1.0

TABLE 5-7 (Continued)

		WATER$^{(a)}$		CUTTINGS
Well	Depth (Feet)	Gross Activity (pCi/l)	^{226}Ra (pCi/l)	^{226}Ra (pCi/g)
11	400	2.1	---	1.0
	500	<2.6	---	0.4
	600	(c)	---	0.5
	700	(c)	---	1.1
	800	(c)	---	0.9
	900	<1.5	---	0.9
	1000	(c)	---	1.1
	1100	<2.0	---	0.8
	1200	<3.8	3.3	0.8
12	300	<1.2	---	4.9
	400	<1.2	---	0.6
	500	1.4	---	0.4
	600	<1.2	---	0.6
	700	<1.1	---	1.0
	800	1.5	000	0.9
	900	1.6	---	1.0
	1000	7.6	4.4	1.9
	1100	<1.5	---	0.8
	1140-1150	<2.5	---	(c)
	1200	<3.0	(b)	0.9
	1220	3.7	---	(c)
	1230	<2.9	---	(c)
	1270	3.1	<2.0	(c)
	1399	(b)	---	0.8
14	400	1.4	---	3.7
	500	1.5	---	0.4
	600	1.9	---	0.5
	700	<1.5	---	1.0
	800	<1.1	---	1.0
	900	<1.3	---	1.3
	1000	2.1	---	1.7
	1100	<3.8	---	0.8
	1150	(b)	<1.1	(c)
	1200	(b)	---	0.9

(a) Filtered through 0.45 um membrane filter.
(b) Sample had solids content too high to permit conventional analysis with required sensitivity.
(c) No data available.

SOURCE: STUDY DATA

TABLE 5-8

RADIOACTIVITY IN SURFACE WATER
MAY THROUGH DECEMBER 1979

	Gross Alpha Activity		Radium Alpha Activity	
	No. Sampled	Concentration (pCi/l) Average (Range)	No. Sampled	Concentration (pCi/l) Average (Range)
Sites	10	<1.7 (<0.9 - 3.4)	8	<1.6 (<0.8 - <2.5)
Months	8	<1.7 (<1.1 - 2.0)	8	<1.8 (<1.2 - 4.2)
Samples	55	<1.7 (<0.8 - 5.5)	16	<1.8 (<0.6 - 5.7)

SOURCE: STUDY DATA

TABLE 5-9

TABULATION OF TOTAL GROSS ALPHA ACTIVITY IN SURFACE WATER

Site	Concentration (pCi/l) for Indicated Month (1979)								Station Summary	
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	No of Months	Concentration (pCi/l) Avg. (Range)
01	2.0	1.2	5.0	1.6	2.1	1.1	3.5	4.8	8	2.7 (1.2-4.5)
02	2.9	<1.2	2.7	<1.0	2.1	1.3	3.4	2.4	8(6)	<2.1 (<1.0 - 3.4)
03	<0.6	<1.0	1.1	<1.0	1.0	1.3	<0.8	<0.8	8(3)	<1.0 (<0.6 - 1.3)
04	(b)	1.3	3.0	1.3	<1.3	0.8	1.9	1.7	7	<1.6 (<0.8 - 3.)
05	<0.6	1.4	(c)	<1.1	1.7	<0.9	<0.9	<0.8	7(2)	<1.2 (<0.6 - 1.7)
06	<0.8	1.1	1.9	<1.0	<0.8	<1.2	(c)	3.1	7(3)	<1.4 (<0.8 - 3.1)
07	(c)	1.8	(c)	2.0	(c)	2.7	(c)	<0.8	4(3)	<1.8 (<0.8 - 2.7)
08	(c)	(c)	(c)	(c)	(c)	5.5	1.3	(c)	2	3,4 (1.3 - 5.5)
09	1.2	(c)	(c)	(c)	(c)	0.8	(c)	(c)	2	1.0 (0.8 - 1.2)
10	(b)	<0.9	0.9	(c)	(c)	(c)	(c)	(c)	2(1)	<0.9 (<0.9 - 0.9)
No of Stations (a)	6(3)	8(5)	6(6)	7(4)	6(5)	9(7)	6(4)	7(4)		
Avg (pCi/l)	<1.4	<1.1	<2.4	<1.3	<1.5	<1.7	<2.0	<2.0		
Range (pCi/l)	(<0.6-2.9)	(<0.9-1.8)	(0.9-5.0)	(<1.0-2.0)	(<0.8-2.1)	(0.8-5.5)	(<0.9-3.5)	(<0.8-4.8)		

(a) Number in parentheses indicates number of samples greater than minimum detectable activity for the individual analysis.

(b) Sample had solids content too high to permit conventional analysis with required sensitivity.

(c) No sample received.

SOURCE: STUDY DATA

TABLE 5-10

TABULATION OF RADIUM ALPHA ACTIVITY IN SURFACE WATER

Site	Concentration (pCi/l) for Indicated Month (1979)								Station Summary	
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	No. of Months*	Concentration (pCi/l) Avg. (Range)
1	2.0	2.4	1.0	-	1.4	-	-	5.7	5(4)	2.5 (1.0-5.7)
2	1.1	-	-	-	-	-	-	2.6	2(1)	1.8 (1/1-2/6)
3	-	-	-	-	1.0	-	-	-	1(0)	1.0
4	-	-	2.8	-	-	-	2.0	-	2(2)	2.4 (2.0-2.8)
5	-	-	-	1.2	-	-	-	-	1(1)	1.2
6	-	-	-	-	-	1.0	-	-	1(0)	1.0
7	-	0.6	-	-	-	0.9	-	-	2(1)	0.8 (0.6-0.9)
8	-	-	-	-	-	3.4	1.0	-	2(2)	2.2 (1.0-3.4)
No. of Stations(a)	2(1)	2(1)	2(1)	1(1)	2(1)	3(2)	2(2)	2(2)		
Avg. (pCi/l)	1.6	1.6	1.9	1.2	1.2	1.5	1.5	4.2		
Range	(1.1-2.0)	(0.6-2.4)	(1.0-2.8)		(1.0-1.4)	(0.9-3.4)	(1.0-2.0)	(2.6-5.7)		

* Number in parentheses indicates number of samples greater than minimum detectable activity for the individual analysis.

SOURCE: STUDY DATA

TABLE 5-11

COMPARISON OF SURFACE WATER AND SEDIMENT RADIOACTIVITY

	SURFACE WATER				SEDIMENT
Site	Gross Alpha (pCi/l) N	Gross Alpha (pCi/l) Avg (Range)	Radium Alpha (pCi/l) N	Radium Alpha (pCi/l) Avg (Range)	Radium-226 (pCi/g)
1	8	2.7(1.2-4.8)	5	2.5(1.0-5.7)	0.4
2	8	2.1(1.0-3.4)	2	1.8(1.1-2.6)	1.1
3	8	1.0(0.6-1.3)	1	1.0	0.6
4	7	1.6(0.8-3.0)	2	2.4(2.0-2.8)	0.9
5	7	1.2(0.6-1.7)	1	1.2	0.6
6	7	1.4(0.8-3.1)	1	1.0	0.3
7	4	1.8(0.8-2.7)	2	0.8(0.6-0.9)	7.4
8	2	3.4(1.3-5.5)	2	2.2(1.0-3.4)	12.9
9	2	1.0(0.8-1.2	0	-	1.4
10	2	0.9(0.9-0.9)	0	-	0.5
Summary:					
Samples	55	1.7(0.8-5.5)	16	1.8(0.6-5.7)	2.6(0.3-12.9)
Site Means	10	1.7(0.9-3.4)	8	1.6(0.8-2.5	2.6

N = Number of months sampled between May and December 1979

SOURCE: STUDY DATA

TABLE 5-12

RADIOACTIVITY IN GROUNDWATER SAMPLES

Sample Number	Collection Date	Radioactivity Concentration Gross Alpha (pCi/l)	Radioactivity Concentration Radium-226 (pCi/l)	Total Solids (mg/l)
Surficial Aquifer				
SA 2	9/26/80	26.3 ± 7.3	9.8 ± 0.4	1,470
SA 3	9/26/80	<5.4	1.1 ± 0.1	191
SA 4	9/26/80	<2.3	-	118
SA 5	9/25/80	6.6 ±5.3	1.8 ± 0.2	348
SA 6	9/25/80	<0.4	-	104
SA 6	2/28/80	<23.2	2.8 ± 0.4	148
SA 7	9/26/80	<4.1	-	716
SA 9	9/25/80	97.4 ± 16.7	14.6 ± 0.5	716
SA 10	9/25/80	<0.9	-	120
SA 11	9/25/80	4.8 ± 4.6	1.1 ± 0.1	176
Upper Floridan Aquifer				
UF 10	2/29/80	48.4± 18.1	4.4 ± 0.3	966
Lower Floridan Aquifer				
LF 6	2/15/80	34.3 ± 8.6	2.3 ± 0.1	328

SOURCE: STUDY DATA

TABLE 5-13

ESTIMATED RADIOLOGICAL CHARACTERISTICS FOR RECLAIMED LANDS
(Conventional Plan)

Landform	Acreage	Gamma Radiation (uR/hr)	Soil Radium-226 (pCi/g)	Radon Flux ($\mu Ci/m^2/sec$)	Working Level (WL)
Sand Tailings Capped with Overburden	5,034	5 (4-7)	3 (2-4)	0.873	0.0082
Overburden Fill	477	5 (4-7)	1 (<1-2)	0.59	0.0068
Above-Grade Clay Settling Areas	6,681	44 (25-85)	22 (12-45)	4.38	0.0172
Above-Grade Clay Capped with Sand Tailings	1,489	9 (7-11)	3 (2-4)	2.05	0.0121
Below-Grade Clay Settling Areas (Wetland)	1,513	(4-85)*	22 (12-45)	4.38	0.0172

Range is shown in ( ).

Calculation source for radon flux and working level: "National Radiation Exposure Assessment: Radioactivity of Lands and Associated Structures," Final Report Volume 2, February 1978, C.E. Roessler, J.A. Wethington, Jr., and W.E. Bolch.

Calculation source for gamma radiation: "National Council on Radiation Protection and Measurements" Natural Background in the United States, Report No. 45, November 1975.

Values for Radium-226 represent the top two feet of material. Calculated from soil characterization.

* The below-grade clay settling areas would be reclaimed as wetlands. The gamma radiation level would vary depending on the depth of water over the soil surface.

TABLE 5-14

ESTIMATED RADIOLOGICAL CHARACTERISTICS FOR RECLAIMED LANDS

(Sand/Clay Cap Plan)

Landform	Acreage	Gamma Radiation (uR/hr)	Soil Radium-226 (pCi/g)	Radon Flux (pCi/m^2/sec)	Working Level (WL)
Sand Tailings Capped with Overburden	5,079	5 (4-7)	3 (2-4)	0.872	0.0082
Clay Capped with Overburden (Above-Grade)	590	38 (22-72)	19 (10-38)	3.67	0.0158
Overburden Fill	432	5 (4-7)	1 (<1-2)	0.59	0.0068
Below-Grade Clay Settling Areas (Wetland)	1,513	(4-85)*	22 (12-45)	4.38	0.0172
Clay Capped with Sand/Clay Mix (4:1)	7,580	18 (14-25)	10 (7-17)	2.25	0.0126

Range is shown in ( ).

Calculation source for radon flux and working level: "National Radiation Exposure Assessment: Radioactivity of Lands and Associated Structures," Final Report Volume 2, February 1978, C.E. Roessler, J.A. Wethington, Jr., and W.E. Bolch.

Calculation source for gamma radiation: "National Council on Radiation Protection and Measurements" Natural Background in the United States, Report No. 45, November 1975.

Values for Radium-226 represent the top two feet of material. Calculated from soil characterization.

* The below-grade clay settling areas would be reclaimed as wetlands. The gamma radiation level would vary depending on the depth of water over the soil surface.

TABLE 5-15

ESTIMATED RADIOLOGICAL CHARACTERISTICS FOR RECLAIMED LANDS

(Sand/Clay Mix Plan)

Landform	Acreage	Gamma Radiation (μR/hr)	Soil Radium-226 (pCi/g)	Radon Flux (pCi/m_2/sec.)	Working Level (WL)
Sand Tailings Capped with Overburden	3,020	5 (4-7)	3 (2-4)	0.873	0.0082
Above-Grade Clay Settling Areas	1,642	44 (25-85)	22 (12-45)	4.38	0.0172
Sand/Clay Mix (2:1)	3,512	22 (16-34)	10 (7-17)	1.71	0.0112
Overburden Fill	1,740	5 (4-7)	1 (<1-2)	0.59	0.0068
Clay Capped with Sand/Clay Mix (2:1)	3,185	22 (16-34)	12 (8-22)	2.20	0.0125
Below-Grade Clay Settling Areas (Wetland)	2,095	(4-85)*	22 (12-45)	4.38	0.0172

Range is shown in ( ).

Calculation source for radon flux and working level: "National Radiation Exposure Assessment: Radioactivity of Lands and Associated Structures," Final Report Volume 2, February 1978, C.E. Roessler, J.A. Wethington, Jr., and W.E. Bolch.

Calculation source for gamma radiation: "National Council on Radiation Protection and Measurements" Natural Background in the United States, Report No. 45, November 1975.

Values for Radium-226 represent the top two feet of material. Calculated from soil characterization.

* The below-grade clay settling areas would be reclaimed as wetlands. The gamma radiation level would vary depending on the depth of water over the soil surface.

TABLE 5-16

ESTIMATED RADIOLOGICAL CHARACTERISTICS FOR RECLAIMED LANDS

(Overburden Mix Plan)

Landform	Acreage	Gamma Radiation (uR/hr)	Soil Radium-226 (pCi/g)	Radon Flux (pCi/m_2/sec)	Working Level (WL)
Sand Tailings Capped with Overburden	3,020	5 (4-7)	3 (2-4)	0.873	0.0082
Overburden Fill	1,740	5 (4-7)	1 (<1-2)	0.59	0.0068
Below-Grade Clay Settling Areas (Wetlands)	2,095	(4-85)*	22 (12-45)	4.38	0.0172
Overburden Sand/Clay Mix (2:1)	5,492	18 (13-32)	8 (5-16)	2.00	0.0126
Clay Settling Areas with Sand/Clay Mix (2:1) Cap	2,847	22 (16-34)	12 (8-22)	2.20	0.0125

Range is shown in ( ).

Calculation source for radon flux and working level: "National Radiation Exposure Assessment: Radioactivity of Lands and Associated Structures," Final Report Volume 2, February 1978, C.E. Roessler, J.A. Wethington, Jr., and W.E. Bolch.

Calculation source for gamma radiation: "National Council on Radiation Protection and Measurements" Natural Background in the United States, Report No. 45, November 1975.

Values for Radium-226 represent the top two feet of material. Calculated from soil characterization.

* The below-grade clay settling areas would be reclaimed as wetlands. The gamma radiation level would vary depending on the depth of water over the soil surface.

6.0 GROUNDWATER

6.1 THE AFFECTED ENVIRONMENT

6.1.1 INTRODUCTION

The geologic formations in the region of the proposed South Fort Meade Mine form a hydrologic system that is divided into aquifers and confining units based on the ability of the materials to yield or restrict the flow of groundwater. This section describes the hydrologic system and is based primarily on information derived from the drilling and hydrologic testing program undertaken at the proposed mine site. Site data were supplemented with information from U.S. Geological Survey (USGS) publications and hydrogeologic studies conducted at other mine sites in the central Florida area.

6.1.1.1 Regional Groundwater Conditions

The groundwater system in southern Polk County consists of a water-table aquifer and an artesian (confined) aquifer system. The water-table aquifer is commonly referred to as the Shallow or Surficial Aquifer. The artesian aquifer system, commonly referred to as the Floridan Aquifer, is one of the most productive aquifers in the United States and is the principal source of potable water in the region. In the area of the proposed mine site, groundwater is used for irrigation, municipal, industrial and domestic supplies. Throughout the region, the artesian-surface elevation varies approximately five to ten feet during the year. These fluctuations are due to changes in barometric pressure, seasonal groundwater demands for irrigation, and variations in aquifer recharge as a result of rainfall patterns.

6.1.1.2 Site-Specific Groundwater Conditions

Site-specific studies of the groundwater system were undertaken to supply required information for a Consumptive Use Permit (CUP) application to the

Southwest Florida Water Management District (SWFWMD) and to provide information for the EIS. Numerous wells were constructed at the proposed site (Figure 6-A), and pumping tests were conducted to determine the aquifer and confining unit properties. Figure 6-B identifies the geologic section and describes the general yield characteristics of the hydrologic formations. The results of the investigations indicate that the hydrologic properties of the aquifers and confining units are similar to those of the region, with the exception of the Shallow Aquifer. At the site, the lithologic variations in the Undifferentiated Clastics containing the Shallow Aquifer have created a less permeable unit in comparison to the general region. The low permeability, however, is consistent with the physical descriptions of materials found during the drilling program.

6.1.2 EXISTING GROUNDWATER USES

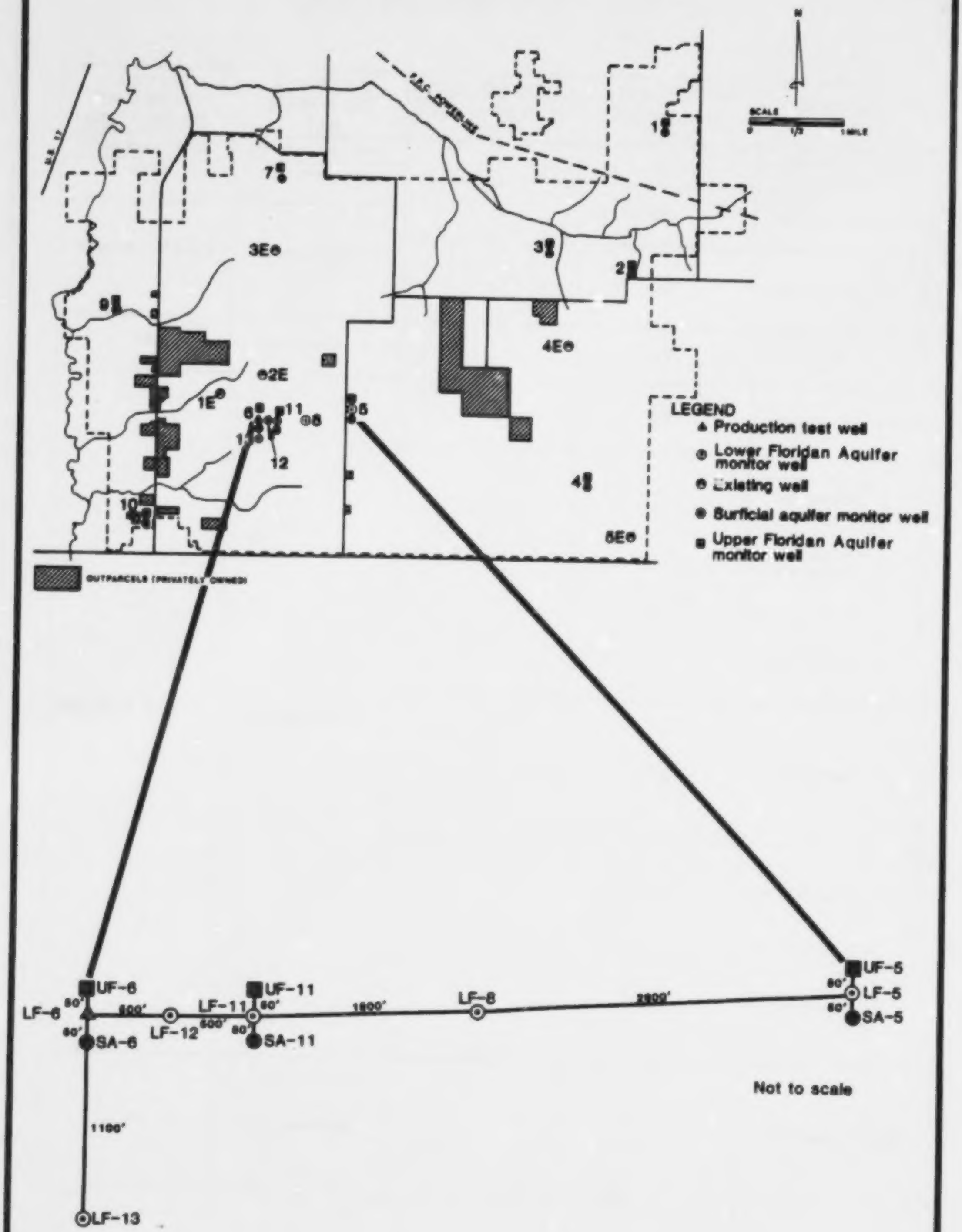
Two surveys were evaluated to determine groundwater usage in the area of the proposed mine site: 1) a well inventory conducted by Mobil, and 2) a computer listing of CUP's granted by SWFWMD. These surveys showed that groundwater is used for domestic supply, irrigation of citrus groves, pasture and crops, municipal supply, and for mining operations. The wells within one mile of the project site identified by the two sources are illustrated in Figure 6-C.

6.1.2.1 Well Inventory

Mobil requested well information from 147 people who, according to Polk County tax records, own property within a one-quarter mile radius of the proposed mine site. Of the 77 responses, 55 of the property owners supplied information on the construction of their wells. This well inventory indicates that the majority of groundwater use in the immediate vicinity of the site is for irrigation and domestic supply. Most of the wells are less than six inches in diameter and withdraw water from the Shallow or Upper Floridan Aquifer. Of the 81 wells located by this survey, only 14 percent penetrate the Lower Floridan Aquifer, the primary source of water for the proposed mining operation.

FIGURE 6-A

TEST WELL LOCATIONS



SOURCE: Study Data

FIGURE 6-B

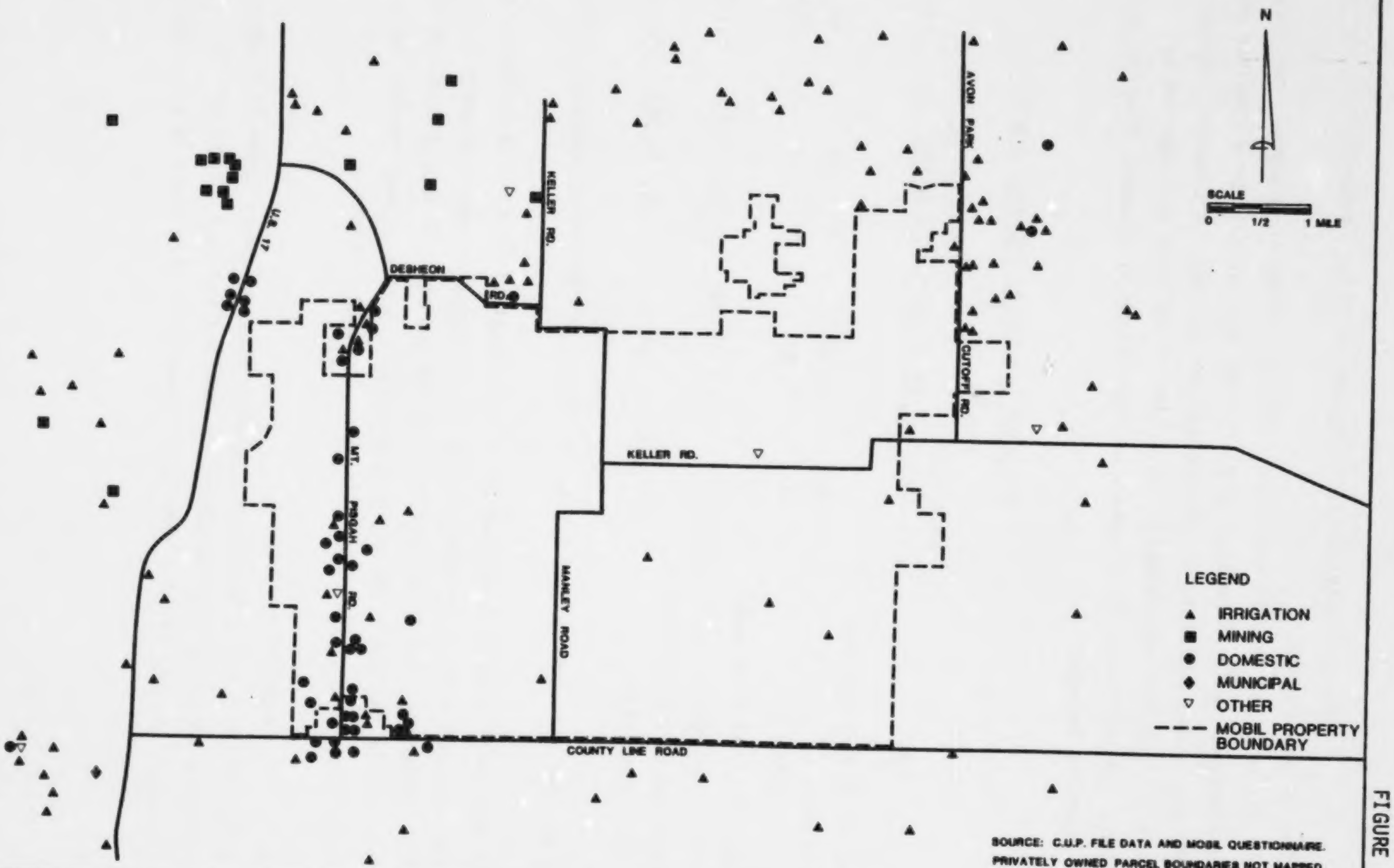
HYDROGEOLOGIC CROSS SECTION OF THE PROPOSED MINE SITE

STRATIGRAPHIC UNIT		APPROXIMATE THICKNESS IN FEET	AVERAGE DEPTH TO TOP OF UNIT IN FEET	AQUIFER & CONFINING UNITS	WATER-PRODUCING PROPERTIES
UNDIFFERENTIATED CLASTICS		45		SHALLOW AQUIFER	POOR TO MODERATE
HAWTHORN FORMATION		80	45	CONFINING UNIT	POOR
TAMPA FORMATION	LIMESTONE UNIT	105	125	UPPER FLORIDAN	POOR TO MODERATE
	SAND & CLAY UNIT	70	230	CONFINING UNIT	POOR
SUWANEE LIMESTONE		90	300	LOWER FLORIDAN	GOOD TO EXCELLENT
OCALA GROUP	CRYSTAL RIVER FORMATION	340	390		
	WILLISTON FORMATION				
	INGLIS FORMATION				
AVON PARK LIMESTONE	LIMESTONE UNIT	275	730		
	DOLOMITE UNIT	160	1005		
	LIMESTONE UNIT	240	1165		
LAKE CITY LIMESTONE			1405	CONFINING UNIT	POOR

SOURCE: STUDY DATA

FIGURE 6-C

GROUNDWATER WELLS IDENTIFIED IN THE VICINITY
OF THE PROPOSED MINE SITE



SOURCE: C.U.P. FILE DATA AND MOBIL QUESTIONNAIRE.
PRIVATELY OWNED PARCEL BOUNDARIES NOT MAPPED.

6.1.2.2 Southwest Florida Water Management District Consumptive Use Permits

CUP's are required for all wells six inches or larger in diameter, for those with a maximum daily withdrawal rate of 1,000,000 gallons, or a combined annual average withdrawal rate of 100,000 gallons per day. A computer listing of 125 CUP's within approximately two miles of the site was supplied by SWFWMD. The following is a summary of the listing by distance from the nearest property boundary:

Item	Less than 1 mile	1 to 2 miles	Greater than 2 miles*	Total
	Distance From Mobil Property Boundary			
No. of Consumptive Use Permits	40	45	40	125
No. of Wells	49	63	77	189
Total Average Withdrawal Rate (gallons)	5,549,872	19,020,152	39,066,126	63,636,150
Total Maximum Withdrawal Rate (gallons)	35,227,510	71,968,450	75,134,348	182,330,308

* Greater than 2 miles but within the limits of the SWFWMD computer listing.

Of the total permitted average daily withdrawal of 63,636,150 gallons within the surveyed area, 2 percent is used for municipal supply, 36 percent is used for irrigation, and 62 percent is used for mining. It should be noted that a majority of the wells inventoried by Mobil's survey do not require CUP's and, therefore, are not included in the SWFWMD computer listing.

6.1.3 HYDROLOGIC CYCLE

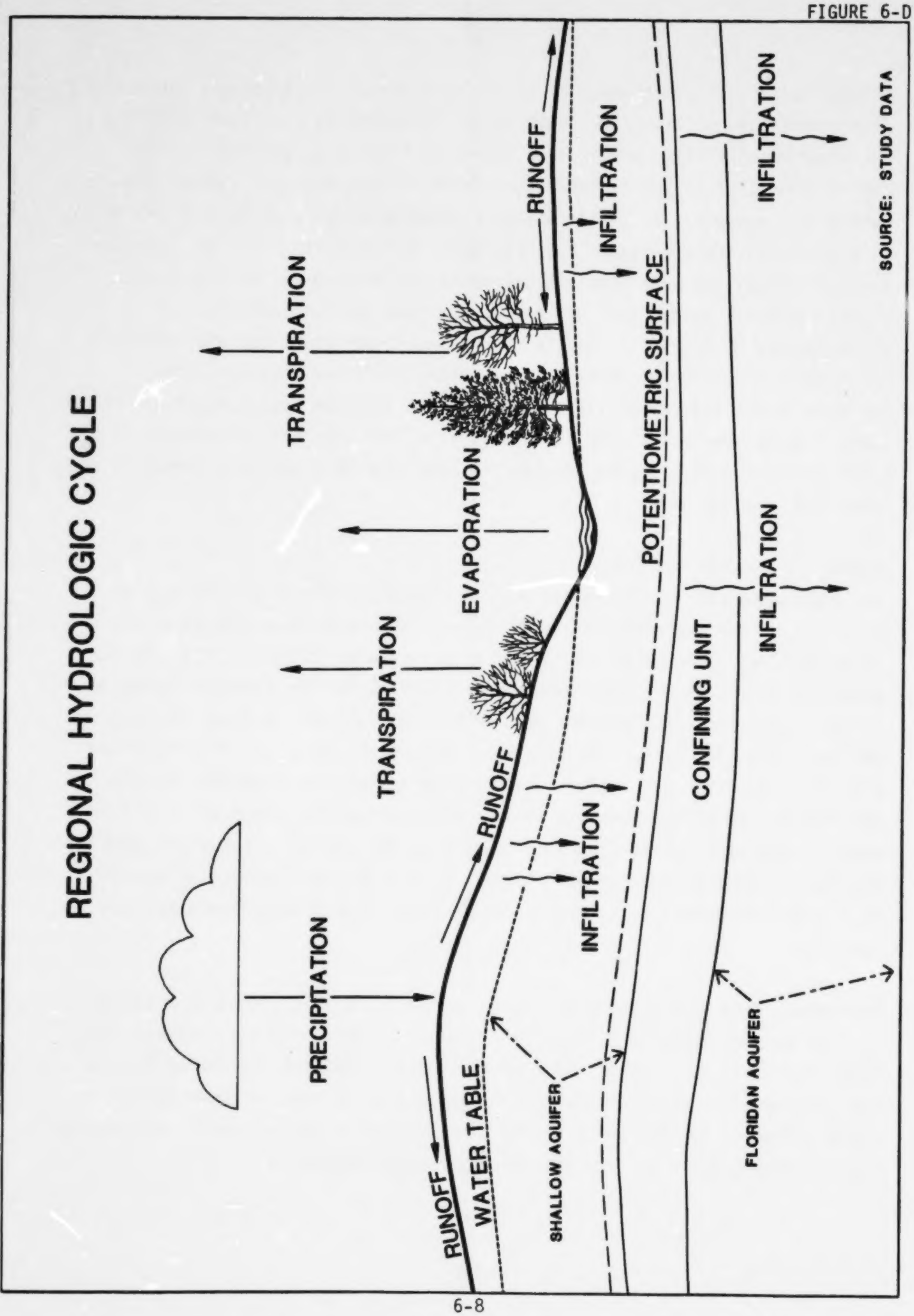
The hydrologic cycle is the continuous process by which water is transported from the oceans to the atmosphere to the land and back to the oceans (Viessman et al., 1972). The basic components of this cycle are evaporation, transpiration (sometimes combined in the term evapotranspiration), surface water runoff and infiltration (recharge). The hydrologic cycle in the area of the proposed mine site, and in this region of Florida in general, is more complex than that just described; this area has two distinct aquifer systems, each with a component of infiltration or recharge (Figure 6-D). Precipitation in the area of the mine site (data collected at the Bartow station) averages about 53 inches per year. Of the precipitation falling on the mine site, approximately 11 inches runs off through surface drainage systems, and approximately 39 inches is lost through evapotranspiration (SWFWMD, 1977). Employing a variation of Darcy's Law (Walton, 1970) and data collected for this study, the calculated recharge to the artesian system was found to be about 3 inches per year. The study data also indicate that groundwater in the Lower Floridan Aquifer flows through the mine site in a westerly direction at about 0.2 feet per year.

6.1.4 SHALLOW AQUIFER

The Shallow Aquifer (or Surficial Aquifer) consists of the more permeable materials of the Undifferentiated Clastics. This unit is generally a water-table aquifer, although in some areas it may be semi-confined. The less permeable materials of the Undifferentiated Clastics and the Hawthorn Formation act as a confining unit between the Shallow Aquifer and the Upper Floridan Aquifer. The Shallow Aquifer is a source of small quantities of groundwater used for irrigation and domestic supply in a few areas. Area-wide studies by the USGS and specific investigations at other mines near the Mobil site have shown values for transmissivity as high as 17,000 gallons per day per foot for the Shallow Aquifer (Borden DRI, 1975). In this area of Florida, an aquifer with such transmissivity is considered to have a low to moderate water bearing capacity.

Overburden core samples were collected at six sites in the general vicinity of Shallow Aquifer Wells SA-3, SA-6, SA-7, SA-9, SA-10 and SA-11. Visual inspections and sieve analyses of these cores indicate that the Shallow Aquifer at the proposed mine site contains more clays and silts than at other nearby sites. Shallow Aquifer wells at the site average 27 feet in depth with yields during pumping tests of less than one gallon per minute.

FIGURE 6-D



REGIONAL HYDROLOGIC CYCLE

SOURCE: STUDY DATA

Ten wells were constructed at the site with intervals screened in the Undifferentiated Clastics. The locations of these wells are shown on Figure 6-A. Figure 6-E is a typical well construction diagram of the Shallow Aquifer wells, and Table 6-1 indicates the well construction details.

Testing of the Shallow Aquifer wells for aquifer properties was undertaken by both drawdown and slug tests. The Papadopulos and Cooper method for large diameter wells and the Jacob straight-line method (Kruseman, 1970) were utilized in the analysis of the drawdown test data. The Ferris (1963), Cooper (1967) and Bouwer (1978) methods were used in the analyses of the slug tests. The results of these tests show that the average transmissivity, based on an aquifer thickness of 25 feet, ranges from 11 to 194 gpd/ft with an average of 55 gpd/ft. In addition to these specific tests, sieve analyses of core samples collected above the phosphate matrix were utilized to derive calculated values of permeability. Assuming an aquifer thickness of 25 feet, the calculated transmissivities ranged from 11 to 43 gpd/ft with an average of 24 gpd/ft. These low transmissivity values compare favorably with the clayey nature of the materials.

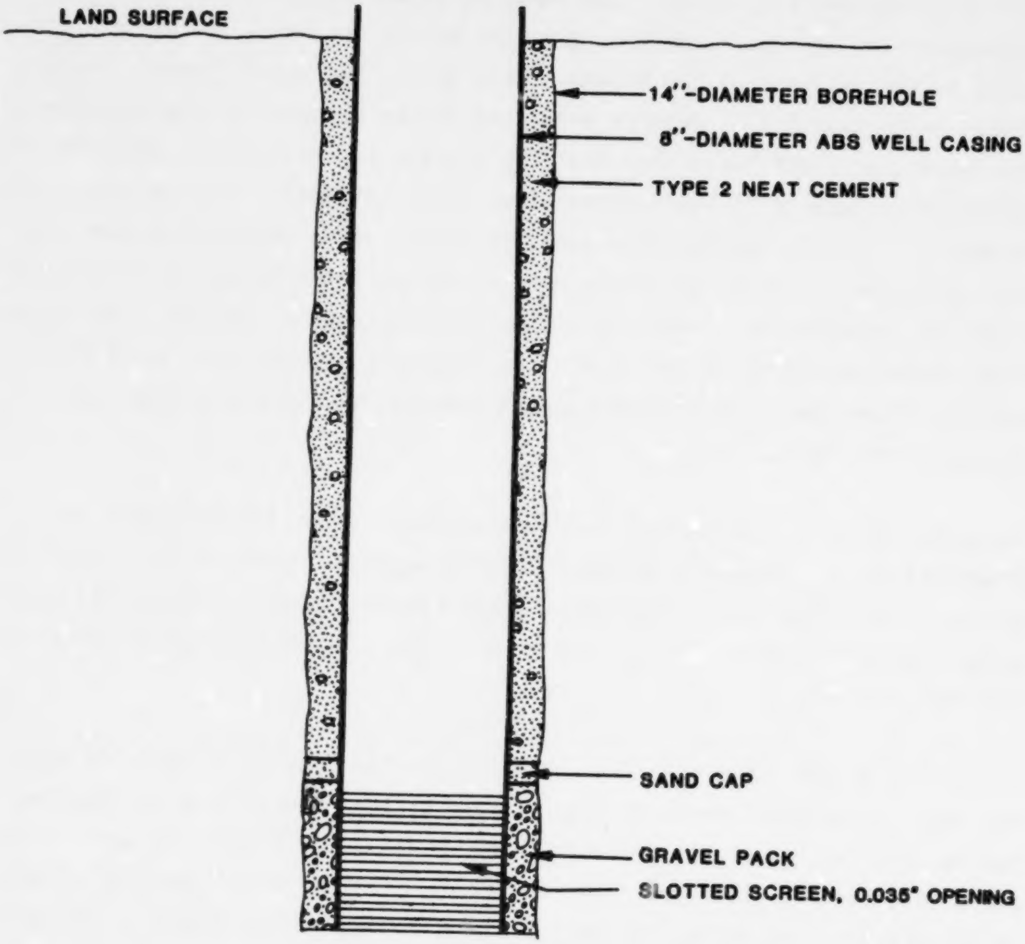
The water level in the Shallow Aquifer remains at least 50 feet above the potentiometric surface of the Upper Floridan Aquifer (Figure 6-F). Under natural conditions, water from the Shallow Aquifer slowly recharges the underlying Upper Floridan Aquifer. This water in turn is transmitted to the Lower Floridan Aquifer.

Dewatering of the Shallow Aquifer at the site will provide a source of water for some operations. Physical examinations of the materials in the Shallow Aquifer and testing of the hydrologic properties confirm that the unit is less productive than in other areas of the region. Depositional characteristics, which determine the nature of the materials in the Shallow Aquifer, have provided a less permeable unit at the proposed mine site than other locations.

6.1.5 FLORIDAN AQUIFER

The Floridan Aquifer is the source of most large, potable, groundwater withdrawals in Polk County, Florida. Wells penetrating this aquifer are commonly capable of producing several million gallons per day. The aquifer is artesian

TYPICAL WELL CONSTRUCTION DIAGRAM OF A SURFICIAL AQUIFER WELL



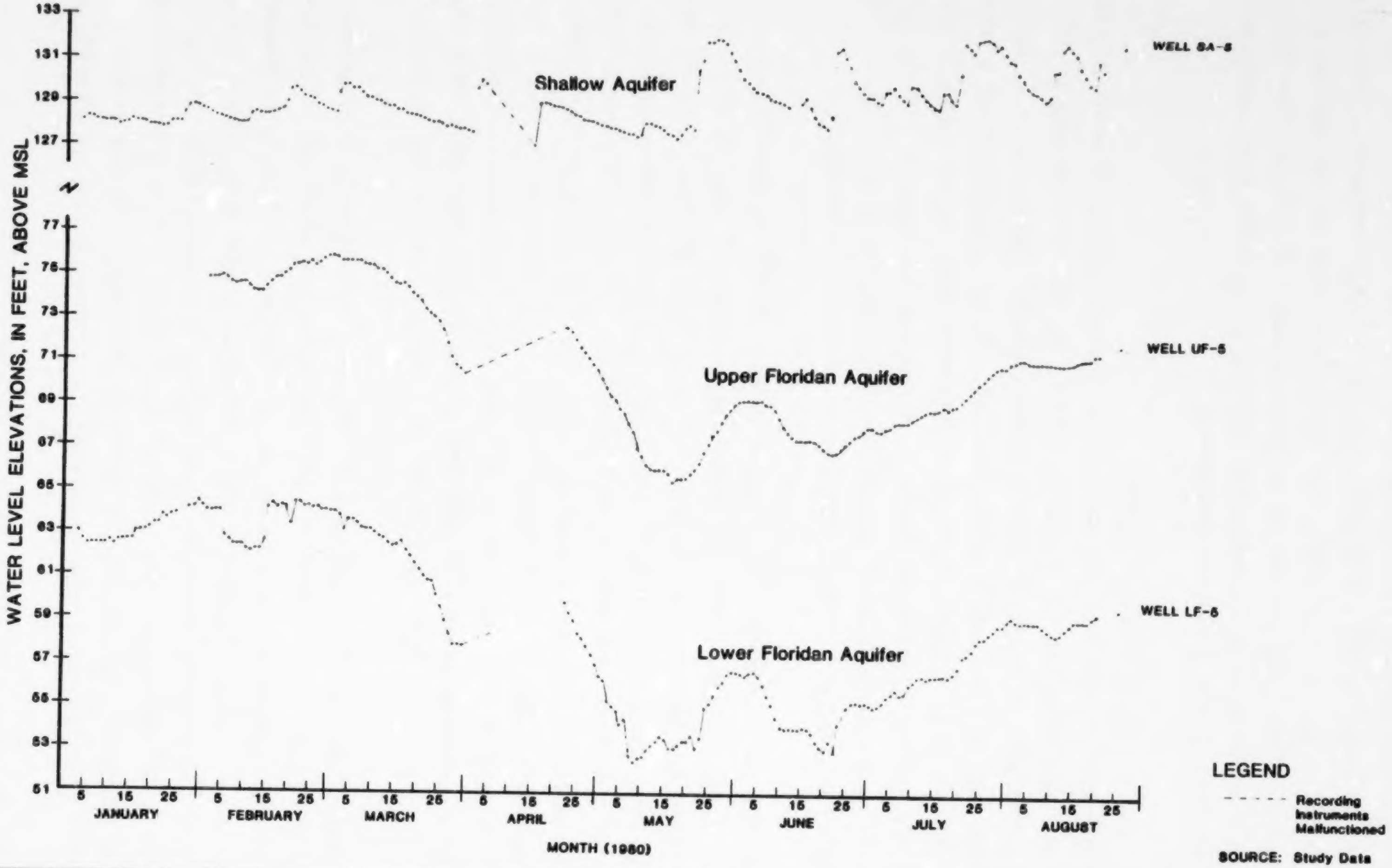
NOT TO SCALE

SOURCE: Study Data

FIGURE 6-F

GRAPH OF WATER LEVEL FLUCTUATIONS

IN WELLS SA-5, UF-5 AND LF-5, JANUARY TO AUGUST 1980



SOURCE: Study Data

and consists of Avon Park Limestone, Ocala Group, Suwannee Limestone and the more permeable materials of the Tampa and Hawthorn Formations (Parker et al., 1955). It may be subdivided into two or more artesian aquifers by the less permeable materials within the artesian system. At the proposed mine site, the Floridan Aquifer is separated into two distinctive units which are described in the following paragraphs.

6.1.5.1 Upper Floridan Aquifer

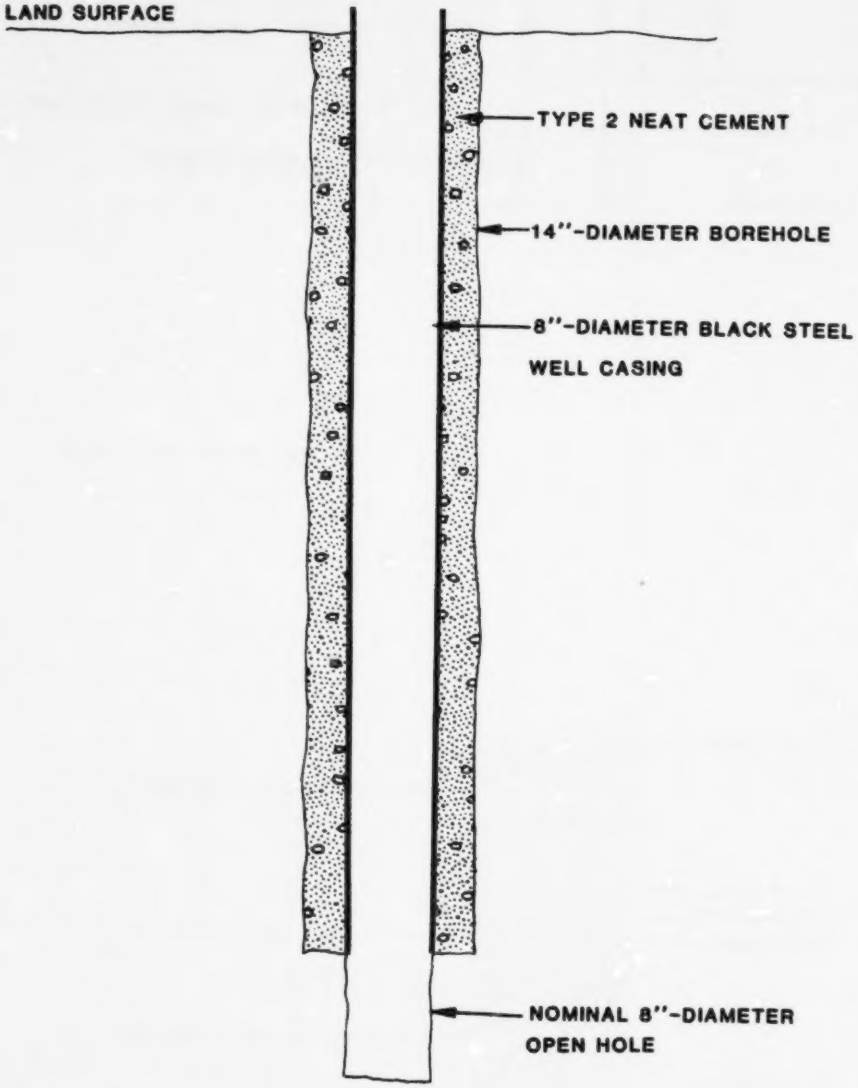
The Upper Floridan Aquifer consists of the more permeable zones of the Hawthorn Formation and the limestone section of the Tampa Formation. This aquifer unit is artesian, with a potentiometric surface about 10 feet higher than that of the Lower Floridan Aquifer. Wells completed in this aquifer are used for local domestic and small irrigation supplies and commonly yield from a few tens of gallons per minute up to several hundreds of gallons per minute. When test pumped, Well UF-10 yielded 30 gallons per minute. Upper Floridan wells drilled at the site extend to an average of 232 feet.

At the proposed mine site, nine wells were drilled to investigate the Upper Floridan Aquifer. Table 6-2 shows the construction details of the wells, and Figure 6-G is a typical construction diagram of the Upper Floridan wells. In addition to these individual wells, LF-12 is a multizoned observation well with a monitor zone open to both the Upper and Lower Floridan Aquifers; a well construction diagram is shown as Figure 6-H. As can be seen in Table 6-2, the open-hole interval in the Upper Floridan wells averages 28 feet in length and is generally from about 200 to 230 feet below land surface. Comparison of the well construction details with the geology of the site shows that these wells are open to the lower section of the limestone unit of the Tampa Formation.

Testing for aquifer properties of the Upper Floridan Aquifer consisted of slug tests at Wells UF-1 and UF-7, and a drawdown test at UF-10. Slug tests are conducted by injecting a known volume of water into a well and measuring the decline in water level with time. Formulas developed by Bouwer (1978), Cooper (1967) and Ferris (1963) were utilized to calculate transmissivity. The transmissivity determined from these tests indicates a value of approximately 10,000 gpd/ft for the entire Upper Floridan Aquifer at the site. An aquifer with such transmissivity is generally considered a poor to moderate producer

FIGURE 6-G

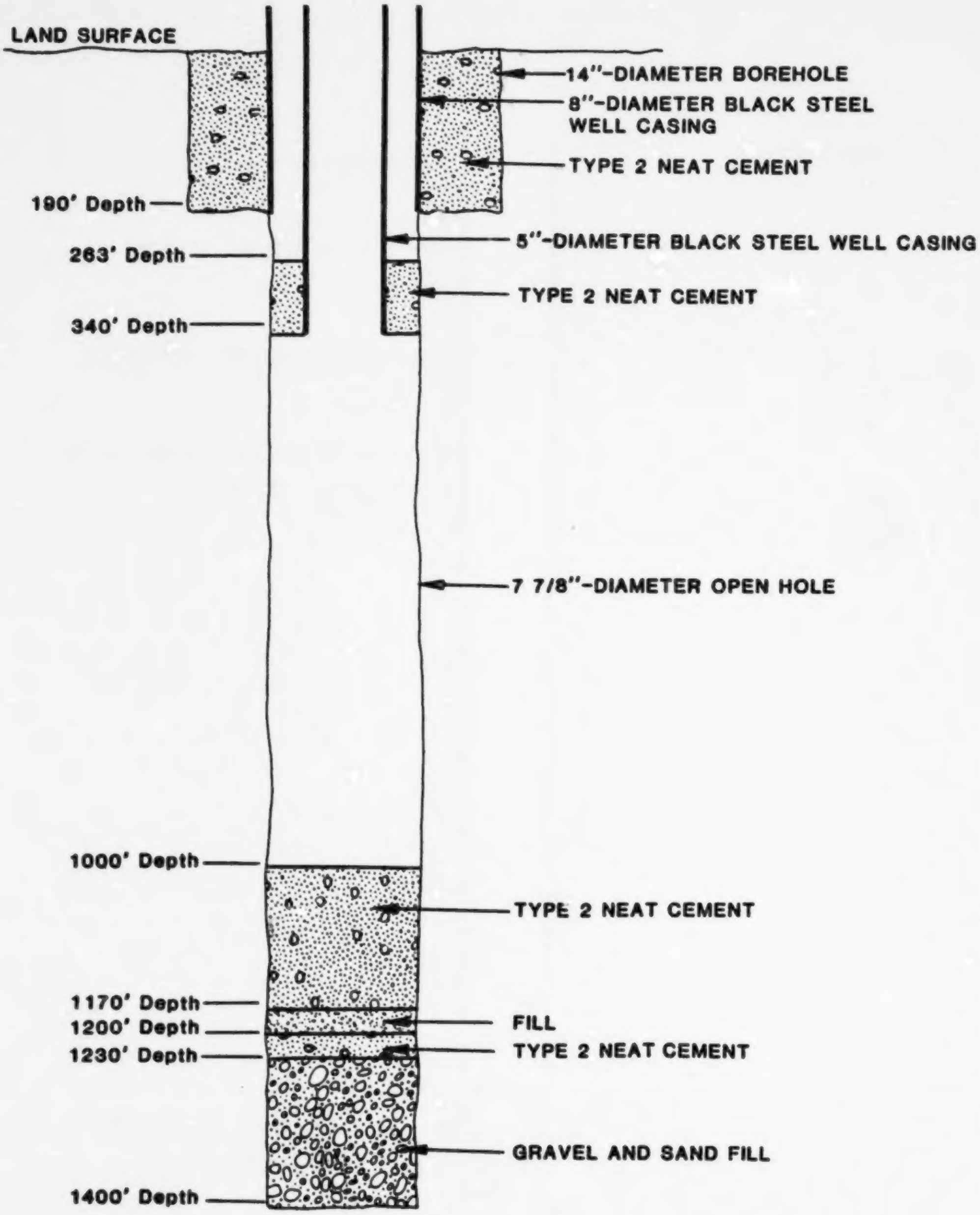
TYPICAL WELL CONSTRUCTION DIAGRAM OF AN UPPER FLORIDAN AQUIFER WELL


LAND SURFACE
TYPE 2 NEAT CEMENT
14"-DIAMETER BOREHOLE
8"-DIAMETER BLACK STEEL WELL CASING
NOMINAL 8"-DIAMETER OPEN HOLE

NOT TO SCALE

SOURCE: Study Data

WELL CONSTRUCTION DIAGRAM OF WELL LF-12 WITH SEPARATE MONITOR ZONES IN THE UPPER AND LOWER FLORIDAN AQUIFERS



NOT TO SCALE

SOURCE: Study Data

in this area of Florida. No accurate values for either storativity or leakance can be determined from these tests.

The potentiometric surface of the Upper Floridan Aquifer is higher than that of the Lower Floridan Aquifer. This feature can be seen in Figure 6-F showing water-level elevations for the Lower Floridan, Upper Floridan and Shallow Aquifer wells at Site 5. The potentiometric surface in Well UF-5 remains ten feet or more above the potentiometric surface of Well LF-5 throughout the eight months of record.

During the ten-day pumping test of Well LF-6 in February, 1980, drawdowns in wells open to the Upper Floridan Aquifer were observed. A comparison of water levels in Upper and Lower Floridan paired Wells UF-5 and LF-5, and UF-11 and LF-11 shows the drawdown in the Upper Floridan wells to be approximately one-third of that observed in the adjacent Lower Floridan wells. These data, in conjunction with the natural water-level differences, indicate that the Upper Floridan is a separate aquifer, although it is hydraulically connected with the Lower Floridan Aquifer.

The Upper Floridan Aquifer will not be utilized as a major source of water at the proposed mine site. Even though local domestic and small irrigation supplies are developed from this aquifer, the productivity of the system makes it extremely difficult to develop the large quantities of water required for the proposed mining operation.

6.1.5.2 Lower Floridan Aquifer

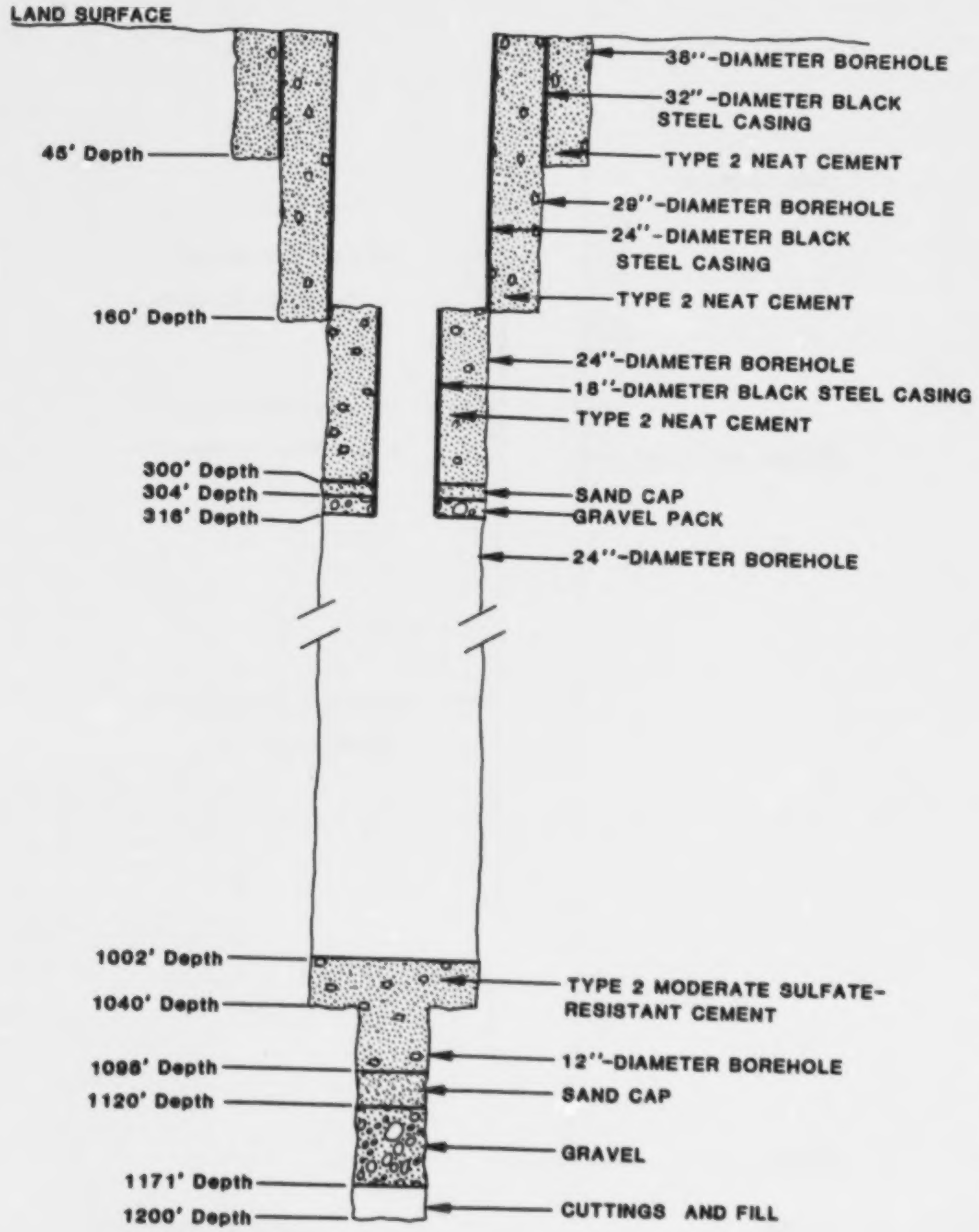
The Lower Floridan Aquifer is an artesian aquifer consisting of the following geologic formations from oldest to youngest: Avon Park Limestone, the Ocala Group and Suwannee Limestone. It is underlain by the evaporite zones (sulfate minerals) of the Lake City Limestone and overlain by sand and clay units of the Tampa Formation (Wilson, 1977). The productivity of wells completed in the Lower Floridan Aquifer ranges from a few hundred gallons per minute to several million gallons per day, depending on the depth penetrated.

Six wells were constructed at the South Fort Meade site that are open to the Lower Floridan Aquifer. One of these wells is a production well; the others are observation wells. Table 6-3 indicates the well construction details and Figures 6-H, 6-I and 6-J are well construction diagrams. The initial openhole interval in these six wells was from about 300 to 1,200 feet below land surface with the exception of Well LF-12 which was drilled to 1,400 feet. Hydrogeologic information at the proposed mine site indicates that the Lower Floridan Aquifer extends from about 300 to approximately 1,400 feet below land surface. The lower zones of this aquifer contain high sulfate water; wells were not, therefore, constructed to the bottom of the aquifer. A more detailed description of the water quality in the Lower Floridan Aquifer is provided in Section 6.1.7.3.

A ten-day aquifer pumping test was conducted in February, 1980 by pumping Well LF-6 at a constant rate of 4,500 gallons per minute (6.5 million gallons per day). This test was conducted to determine the aquifer properties of the Lower Floridan Aquifer and to observe the effects of the pumping on overlying formations. Water-level data were collected from wells on and near the proposed mine site. A recording barometer was operated throughout the test and water levels measured in wells at a distance from the pumping well site were collected for utilization in correcting observed water-level changes for effects other than the pumpage from Well LF-6. The observed drawdowns were corrected for regional water-level changes by using the U.S. Geological Survey (USGS) Maddox Well located seven miles west of the pumping well.

The corrected data were analyzed by the Hantush-Jacob curve-matching method and the Hantush inflection-point method (Kruseman, 1970) to determine aquifer characteristics. Figure 6-K is a semi-logarithmic plot of Observation Well LF-11 showing drawdown versus time data during the LF-6 test and the methodology of the Hantush inflection-point method. Figure 6-L is a full-logarithmic plot of Observation Well LF-11 also showing the drawdown versus time data during the test and the methodology of the Hantush-Jacob curve-matching method. Figure 6-M is a semi-logarithmic plot of the drawdown in Pumping Well LF-6. The total drawdown in Well LF-6 after pumping 6.5 million gallons per day for a period of ten days was 8.2 feet. A summary of the analytical results of the test are presented in Table 6-4.

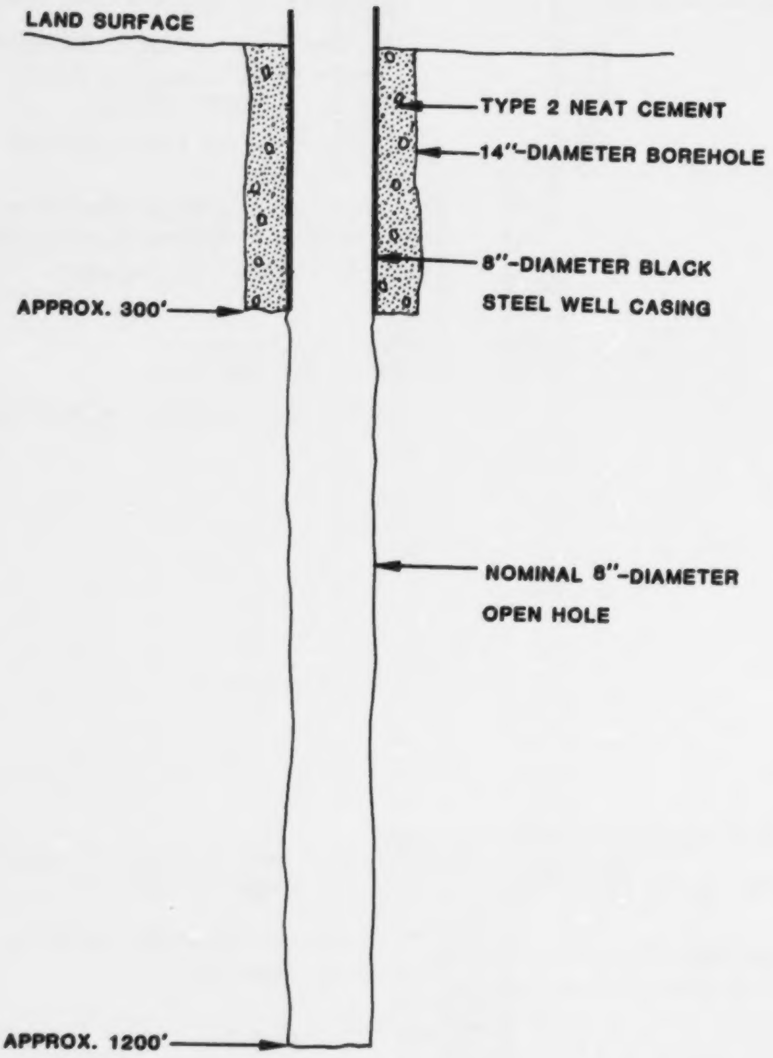
WELL CONSTRUCTION DIAGRAM OF LOWER FLORIDAN AQUIFER WELL LF-6



NOT TO SCALE

SOURCE: Study Data

GENERAL WELL CONSTRUCTION DIAGRAM OF LOWER FLORIDAN AQUIFER WELLS (LF-5, LF-8, LF-11 AND LF-13)



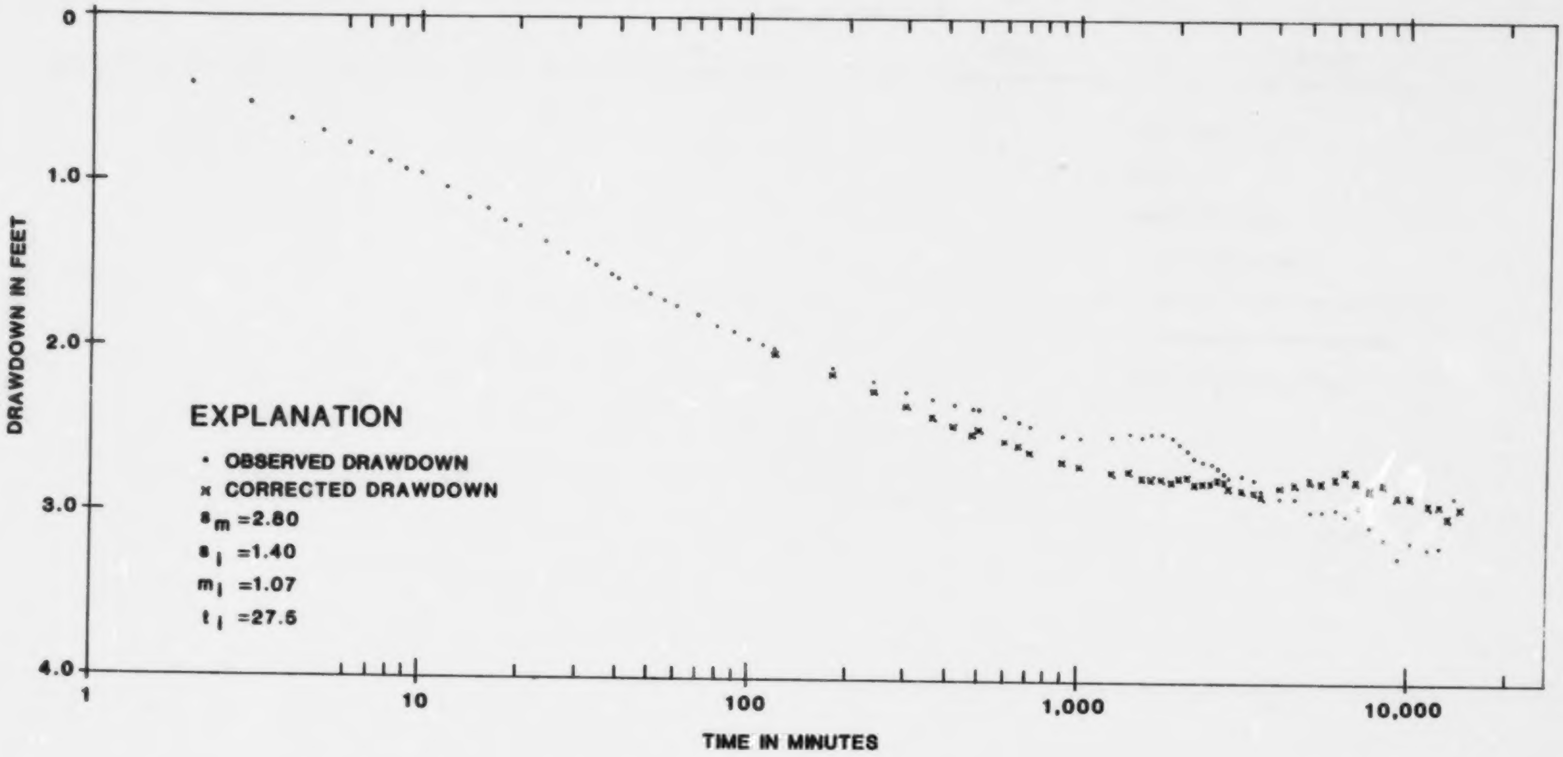
NOT TO SCALE

SOURCE: Study Data

FIGURE 6-K

DRAWDOWN IN WELL LF-11 / SEMI-LOG PLOT

WHEN PUMPING WELL LF-6 AT 4,500 GPM, DURING 10-DAY PUMPING TEST, FEBRUARY 1980

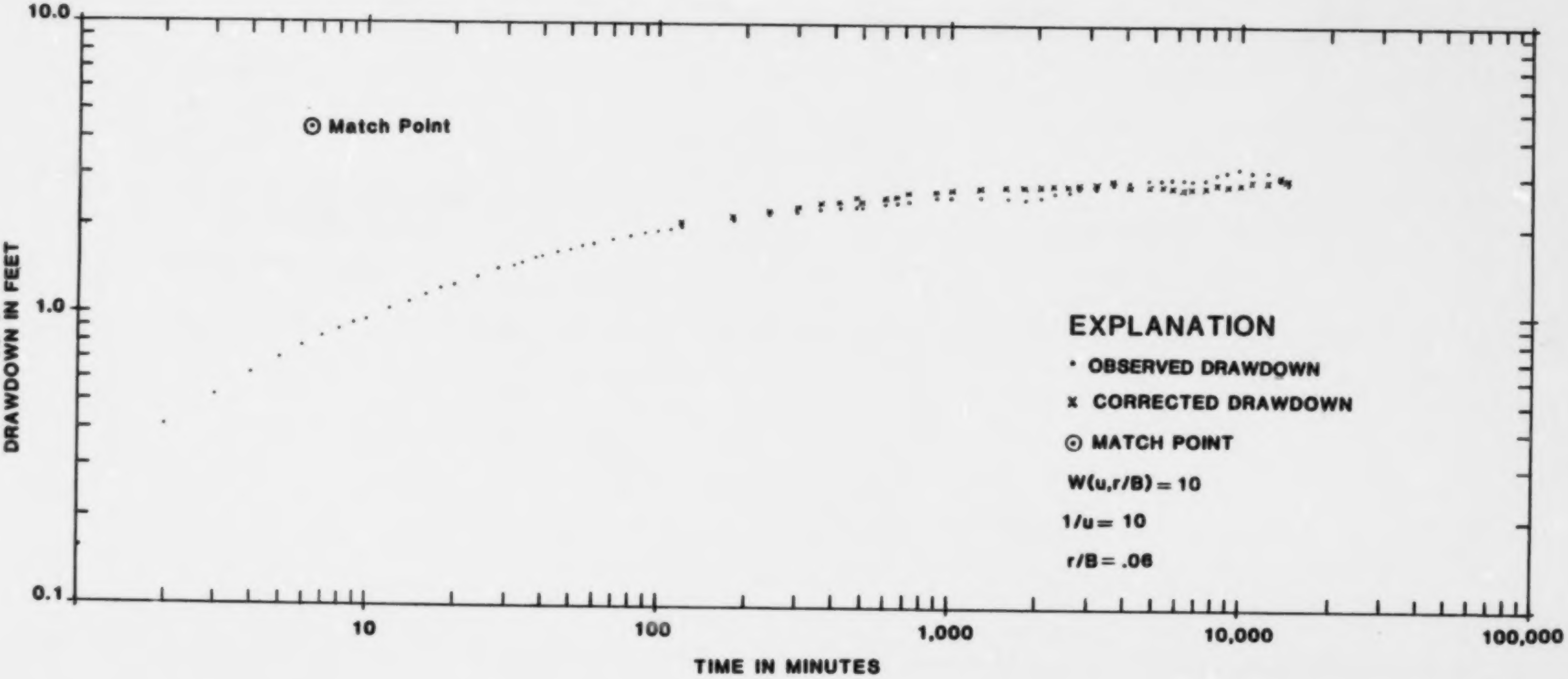


SOURCE: Study Data

FIGURE 6-L

DRAWDOWN IN WELL LF-11 / LOG-LOG PLOT

WHEN PUMPING WELL LF-6 AT 4,500 GPM, DURING 10-DAY PUMPING TEST, FEBRUARY, 1980

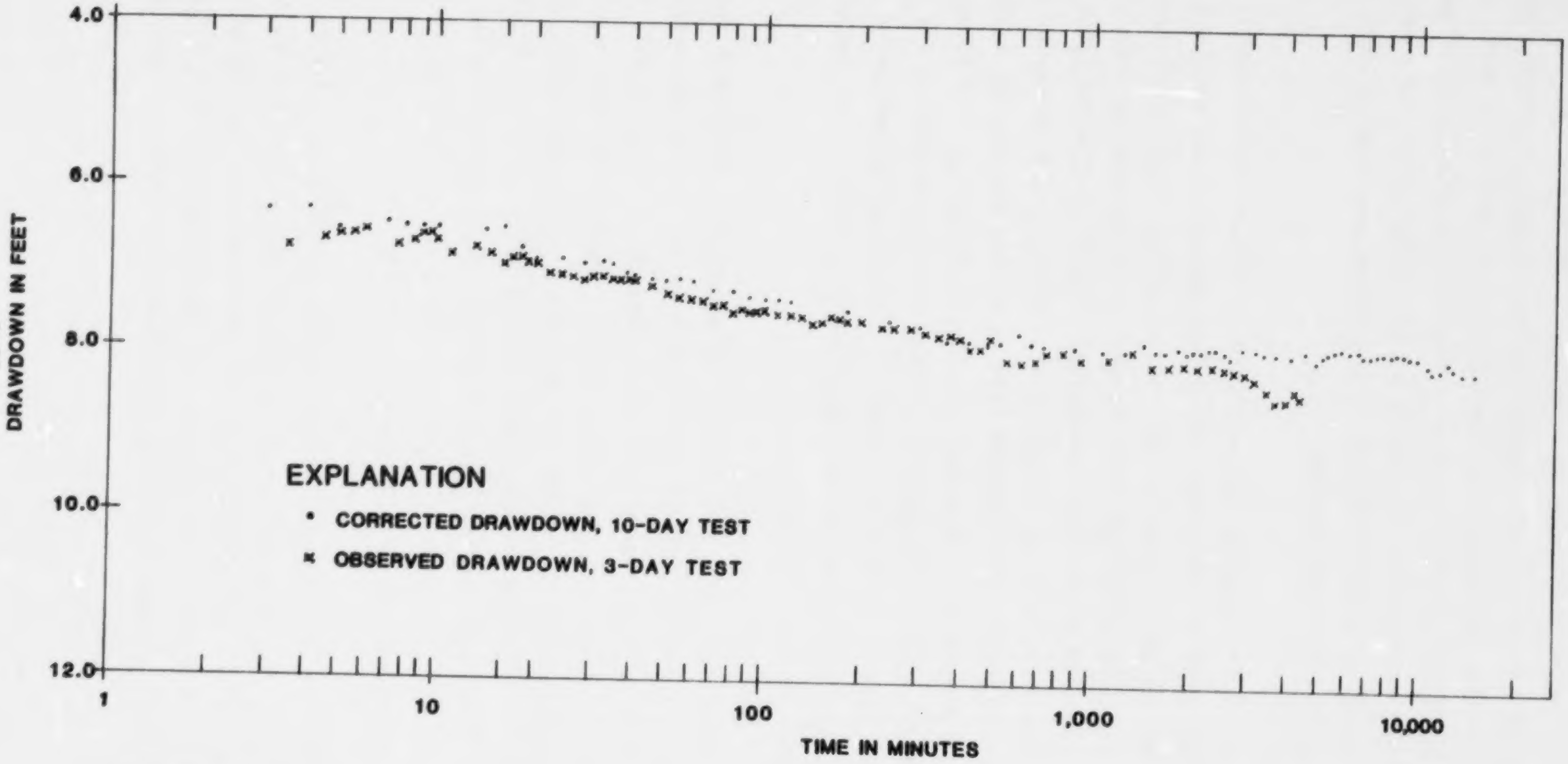


SOURCE: Study Data

FIGURE 6-M

DRAWDOWN IN WELL LF-6 / SEMI-LOG PLOT

WHEN PUMPING WELL LF-6 AT 4,500 GPM, DURING 10-DAY AND 3-DAY PUMPING TESTS, FEBRUARY AND APRIL, 1980



SOURCE: Study Data

The most representative values of the aquifer parameters are as follows: transmissivity (the ability of the aquifer to move water): 1,300,000 gpd/ft; storativity (the ability of the aquifer to store water): 0.0002, unitless; and leakance (a measure of the ability of the confining units to allow water to move into the aquifer): 0.002 gpd/ft^3. An aquifer with a transmissivity of this magnitude is regarded as highly productive and able to yield several million gallons of water per day.

During the ten-day pumping test an increase in the concentrations of some chemical constituents in the water pumped from Well LF-6 was observed. Geophysical logs of the well indicated that the zone from about 1,000 feet to 1,200 feet was a source of high-sulfate water. In an attempt to determine if this increase could be eliminated, the bottom of Well LF-6 below 1,000 feet was sealed. The same zone was sealed in Well LF-12, and a three-day pumping test was conducted at the same pumping rate as during the ten-day test. The primary purpose of the three-day test was to determine if sealing the bottom of the wells affected the aquifer characteristics or changed the chemical quality of the water. Neither the chemical quality of the water nor the aquifer characteristics changed. A more detailed discussion of the water quality data is included in Section 6.2.7.3.

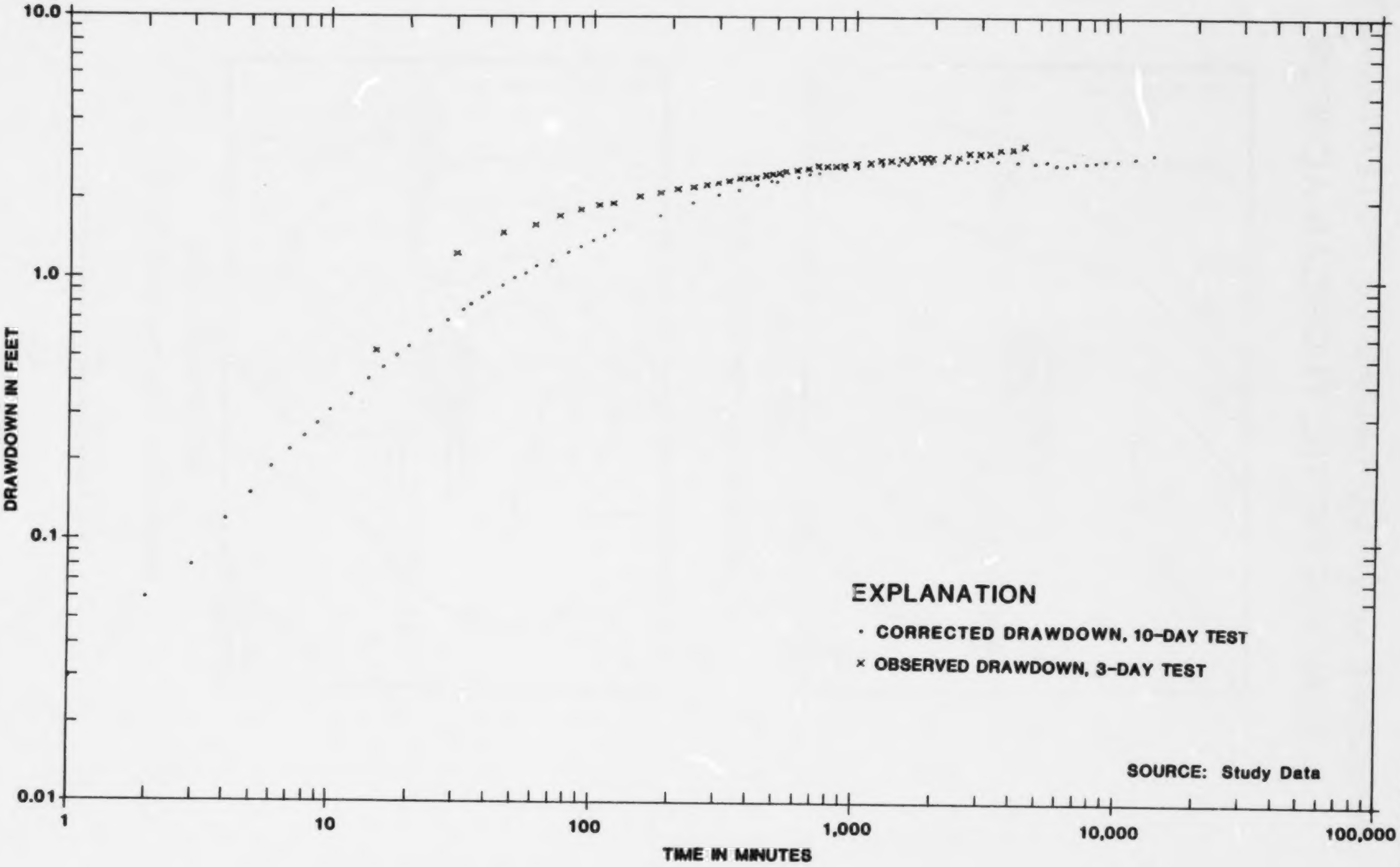
A semi-logarithmic plot of the observed drawdown in Well LF-6 during the three-day test is included with the corrected drawdown in the same well during the ten-day test in Figure 6-M. Due to the reduction in the amount of open hole as a result of sealing, a slightly greater drawdown was observed during the Or three-day test than during the ten-day test. Full-logarithmic plots of Observation Well LF-12 for the three and ten-day tests are shown in Figure 6-N. Although there are some differences between the two tests in the early-time drawdowns, the later-time data, as expected, exhibit only slightly more drawdown in the three-day test than in the ten-day test.

Water levels in the Lower Floridan Aquifer at the proposed mine site vary during the year from the dry season to the wet season by about 10 feet or more. Figure 6-O shows the elevation of the potentiometric surface of the proposed mine site as mapped by the USGS in September, 1979 and May, 1980. Figure 6-F is a hydrograph showing water-level elevations at the site of Well LF-5 for

FIGURE 6-N

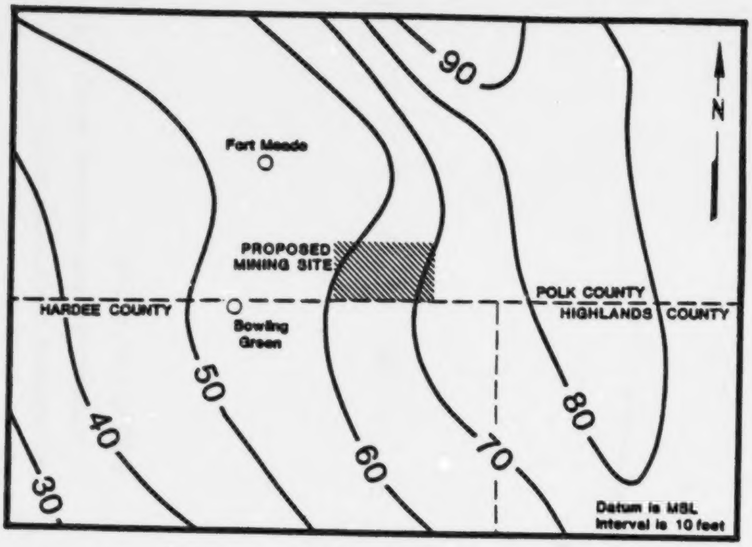
DRAWDOWN IN WELL LF-12 / LOG-LOG PLOT

WHEN PUMPING WELL LF-6 AT 4,500 GPM, DURING 10-DAY AND 3-DAY PUMPING TESTS FEBRUARY AND APRIL, 1980



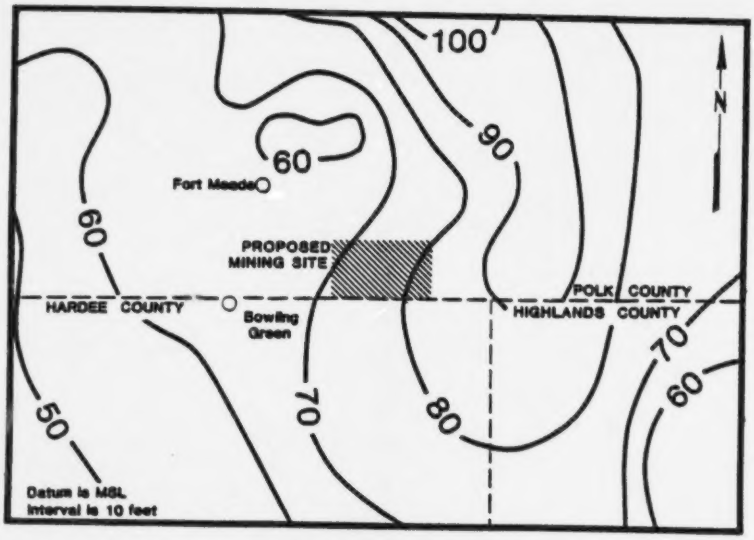
SOURCE: Study Data

REGIONAL CONTOUR MAPS OF POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER



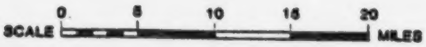
MAY, 1980

SOURCE: U.S.G.S. OPEN FILE REPORT 80-587



SEPTEMBER, 1979

SOURCE: U.S.G.S. OPEN FILE REPORT 80-270



the period of record. This hydrograph shows a maximum fluctuation in the Lower Floridan water levels of about 12 feet for the period of record. These fluctuations are the result of natural phenomena such as barometric pressures and seasonal rainfall occurrences, as well as human utilization of the groundwater resource. Industrial pumping remains relatively stable throughout the course of a year, whereas withdrawals for irrigation will vary considerably from season to season and even from year to year (EPA, 1978). The irrigation requirements magnify the fluctuations observed in the groundwater system.

The pumping rate of 6.5 million gallons per day from Well LF-6 indicates that large quantities of water can be withdrawn from the Lower Floridan Aquifer. The water level in Well LF-6 at the end of the test was 8.2 feet below the prepumping level. As a result of the pumping, water levels in the Lower Floridan Aquifer declined about 1.4 feet at the closest property boundary and less than one foot at the farthest boundary. Hydrologic properties of the aquifer of transmissivity, storativity and leakance compare favorably with those determined for this region in studies conducted by the USGS (Wilson, 1980). The aquifer is a productive source of water for industrial, agricultural and municipal uses.

6.1.6 CONFINING UNITS

The hydrogeologic system at the site consists of separate units with differing hydrologic properties. The Lower Floridan Aquifer is a permeable, highly productive unit capable of supplying large quantities of groundwater. Other units are much less permeable and create the confined or artesian conditions that have been observed. It is the overlying confining units through which recharge to the Lower Floridan Aquifer must occur, and it is the underlying confining units that protect the quality of water from the highly mineralized waters below.

Three confining units were identified at the proposed mine site. The base of the Lower Floridan Aquifer is confined by the underlying evaporite zones of the Lake City Formation. The top of the Lower Floridan Aquifer is confined by the sand and clay units of the Tampa Formation. The Upper Floridan Aquifer is overlain by clayey units of the Hawthorn Formation and the silty and clayey portions of the Unidifferentiated Clastics. These confining units are described in detail in the following paragraphs.

6.1.6.1 Lake City Limestone

The upper units of the Lake City Limestone, in which the pore spaces are filled or partially filled with evaporites, act as the basal confining unit for the Lower Floridan Aquifer. The occurrence of evaporites has been observed in deep wells drilled elsewhere in Florida and has been studied extensively at several sites. Testing of the evaporite units has shown extremely low values of permeability in comparison to those of the overlying productive zones of the Lower Floridan. Following the ten-day pumping test at Well LF-6, LF-11 was deepened to a depth of 1,466 feet in order to accurately determine the top of the evaporite zone. The first evaporites in the well cuttings were observed at a depth of about 1,400 feet, while more massive evaporites were observed at about 1,450 feet. From this information, the top of the Lake City Limestone confining unit is determined to be approximately 1,400 feet below land surface.

6.1.6.2 Tampa Formation

The sand and clay section of the Tampa Formation acts as a confining unit between the Upper and Lower Floridan Aquifers. Comparison of water levels in these aquifers shows about a ten-foot difference in potentiometric levels. During the ten-day pumping test of Well LF-6, drawdowns in the Upper Floridan Aquifer were observed to be approximately one-third of those in the Lower Floridan Aquifer. These data show that the confining unit of the Tampa Formation creates a separation between the aquifers, although there is some hydraulic communication between them.

6.1.6.3 Hawthorn and Undifferentiated Clastics

The clayey and silty zones of the lower portions of the Undifferentiated Clastics and the clayey units of the Hawthorn Formation act as confining units between the Surficial Aquifer and the Upper Floridan Aquifer. Comparison of the water-level elevations in the Surficial Aquifer with those of the Upper Floridan Aquifer shows at least a 50-foot difference in head, the water table having a higher elevation. This indicates that a tight confining unit exists between these aquifers.

6.1.7 GROUNDWATER QUALITY

The chemical quality of groundwater depends on many factors, including the initial quality of the water when it recharges the aquifers, the composition of the rocks through which the water moves, and the length of time the water is in circulation in the groundwater system.

The quality of groundwater in the Shallow Aquifer varies considerably in the region as a result of lithologic changes that occur over short distances. In general, however, water in the Shallow Aquifer is high in iron concentration and has a pH value less than seven. It is used in some cases for private domestic supplies and for agricultural irrigation.

On a regional basis, water from the Floridan Aquifer is of suitable quality to be utilized for potable water supplies, for industrial processing requirements and for agricultural irrigation. Throughout the region, the groundwater quality is relatively consistent in the Floridan Aquifer except for certain areas along the Gulf of Mexico where salt water intrusion has been experienced, and beneath the potable zones of the Floridan Aquifer where incomplete flushing of the natural system or the presence of certain minerals has left highly mineralized water. Data from the drilling program conducted at the proposed mine site have shown the existence of the mineralized waters below the potable horizons of the Floridan Aquifer.

To evaluate the quality of the groundwater at the site, water samples were collected during the hydrogeologic data collection program. Selected chemical constituents of the water from the Shallow Aquifer and from both the upper and lower units of the Floridan Aquifer were analyzed. The methods of sample collection and the chemical constituents analyzed are described in the following sections.

The majority of groundwater, utilized for mining and processing requirements at the site, will be withdrawn from the Lower Floridan Aquifer. For comparative purposes, the chemical constituents of water samples collected at the proposed site are compared to the Interim Primary and Secondary Drinking Water Standards of the Environmental Protection Agency and the State of Florida Class I-B Water Quality Criteria (Potable and Agricultural Water Supplies and

Storage Groundwaters). The state standards relate to all groundwater with total dissolved solids less than 10,000 mg/l which are used or can reasonably be expected to be used for potable supply (FAC Chapter 17-3, 1980).

6.1.7.1 Shallow Aquifer

A water sample was obtained by a grab technique from Well SA-6 on February 18, 1980, and analyzed for the chemical constituents shown in Table 6-5. On September 25 and 26, 1980, additional water samples were obtained with a portable sampling pump from nine of the ten Shallow Aquifer wells. The day before the September sampling, the wells were pumped dry to assure that representative water samples would be collected. Analyses of the chemical constituents of the water from these wells are also shown in Table 6-5.

Although the Shallow Aquifer water will not be utilized at the proposed mine site for potable supplies, a summary of analyses of the nine well samples is compared in Table 6-6 for comparative purposes with the EPA drinking water standards and the Florida Class I-B Standards. As would be expected, the water has a low pH and contains relatively high concentrations of iron. The high concentration of color may be attrituted to the combination of the drilling technique in association with the high concentration of natural clays in the formation, and may also be due to incomplete flushing of the well. The higher values of the various constituents found in some of the well samples, particularly in Wells SA-2 and SA-5, are the cause of the higher total dissolved solids.

A comparison of the February and September, 1980 data collected from Well SA-6 revealed relatively stable water quality conditions for most parameters, with the greatest exception occurring in the TOC results. The extreme variation in the TOC samples may be related to incomplete flushing of the well during the February sampling. Acidity was slightly lower and total alkalinity slightly higher at the February sampling. Sulfate, calcium and magnesium concentrations were all lower during the September sampling.

In general, the analyses indicate that the composition of the water is typical of that normally found in the near surface sands and clays. Variations in chemical characteristics of the water from well to well are representative of lithologic changes in the Shallow Aquifer. The variations of the water quality from the Shallow Aquifer at the site are similar to those noted from Shallow Aquifer wells at the Estech Duette Mine, CF Industries Hardee County Mine, and at other locations in the region.

6.1.7.2 Upper Floridan Aquifer

On February 29, 1980, a water sample was collected from Well UF-10 with a vertical turbine pump, and the sample was analyzed for the selected chemical constituents shown in Table 6-6. The water in the Upper Floridan Aquifer is more mineralized than that found in the Shallow Aquifer, particularly with respect to constituents derived from the carbonate rock which makes up this aquifer. This increase in mineralization is due to higher values of sulfate, calcium, alkalinity, total hardness and total dissolved solids. The pH and conductivity increased, and iron, total phosphorus, and orthophosphate concentrations decreased in the sample of Well UF-10 as compared to the average of the samples from the Shallow Aquifer. Fluoride and strontium values were also higher in the sample collected from the Upper Floridan Aquifer. The values for color, cadmium and iron from Well UF-10 exceed the EPA standards for drinking water, and fluoride and cadmium values exceed Florida Class I-B Standards. The Upper Floridan Aquifer will not be utilized as a major source of groundwater at the site. The chemical composition of the water from the Upper Floridan Aquifer at the proposed mine site is generally similar to that of wells penetrating the same aquifer at the Estech Duette Mine, CF Industries Hardee County Mine, and at other locations in the region.

6.1.7.3 Lower Floridan Aquifer

The majority of water utilized for mining and processing at the proposed mine site will be withdrawn from the Lower Floridan Aquifer. As indicated by the existing information on the region and as is evident from the data collection program at the site, the Lower Floridan Aquifer contains potable water in the middle and upper portions of the aquifer. Highly mineralized water is found with increasing depth due to the dissolution of sulfate minerals known to exist in the lower sections of the aquifer.

The increase in mineralization at the site is evident from samples collected below 800 feet during the reverse-air drilling of six Lower Floridan wells.

As can be determined from Table 6-7, the concentrations of sulfates increased from an average of 96 milligrams per liter (mg/l) at a depth of 800 feet to an average of 646 mg/l at 1,200 feet. Significant increases in conductivity and total dissolved solids were also observed between 800 and 1,200 feet. Chloride concentrations remained constant at these depths. It should be noted that the reverse-air samples represent a blend of water from the total openhole interval rather than from a specific depth.

Indications of poor quality water below 1,200 feet in the Lower Floridan Aquifer are evident from samples collected during the reverse-air drilling of Well LF-12 to a depth of 1,400 feet. As shown in Table 6-8 conductivity values increased from 460 micromhos per centimeter (umhos/cm) at a depth of 1,140 feet to 2,900 umhos/cm a depth of 1,399 feet. A thief sample, which represents water quality characteristics at a specific depth, was obtained from the bottom of Well LF-12 after the drilling activities had ceased. The concentrations of sulfates and total dissolved solids of this bottom sample, as shown in Table 6-9 were 1645 mg/l and 3072 mg/l, respectively.

A ten-day pumping test of Lower Floridan Well LF-6 was conducted from February 5, 1980 to February 15, 1980. During the test, water samples were collected from the discharge pipe of LF-6 and analyzed for the constituents shown in Table 6-10. The results indicate that the sulfate content increased from 255 mg/l after two hours of pumping to more than 500 mg/l after approximately one week of pumping, and then remained fairly constant until the end of the test. Total dissolved solids increased from 588 mg/l after two hours of pumping to more than 1000 mg/l after approximately eight days of pumping, and then remained constant until the end of the test. An increase in conductivity values were observed throughout the test, rising from 790 umhos/cm after two hours of pumping to 1,042 umhos/cm at the end of the ten-day test; however, little change was noted during the latter part of the test. Chloride values remained essentially constant (12 mg/l to 13 mg/l) during the test, as did the other chemical constituents.

At the end of the ten-day test, a water sample was obtained from Well LF-6. The constituents analyzed are shown in Table 6-6 along with the EPA drinking water standards and the State Class I-B Standards for comparative purposes.

As noted in the table, total dissolved solids and sulfate values, whose concentrations are affected by the presence of sulfate minerals, exceed the recommended EPA standards, and the cadmium value exceeds both state and Federal standards. The chemical analysis of the water from LF-6, however, is similar to other wells in the area which are open to approximately the same depth in the Lower Floridan Aquifer.

Upon completion of the ten-day aquifer test, additional investigations were conducted to better define the hydrogeologic conditions in the basal portion of the Lower Floridan Aquifer. Thief samples collected at a depth of 1,200 feet from Wells LF-8, LF-11 and LF-13 indicate the presence of high-sulfate water at this depth (Table 6-11). To eliminate this poor quality water, Wells LF-6 and LF-12 were plugged to a depth of 1,000 feet to determine if confining beds were present which would prevent the upward movement of the high-sulfate water into the borehole. Analyses of water samples shown in Table 6-12 were obtained during a three-day pumping test of Well LF-6 which was conducted upon completion of the plugging operations. The results were essentially the same as those determined within the same time interval of the ten-day test conducted prior to backfilling.

To confirm the presence of the evaporites, Well LF-11 was deepened from a depth of 1,200 feet to 1,466 feet. Analyses of water samples obtained during the investigation are shown in Table 6-13. The results represent a blend of the water from the total open-hole interval and indicate the increase in mineralization with depth. As can be seen below from the evaluation of thief samples obtained from Well LF-11, highly mineralized water is present in the bottom of the borehole.

Date	Depth (feet)	Chloride (mg/1)	Sulfate (mg/1)	Total Dissolved Solids (mg/1)
7/9/80	900	14.1	49.7	317
7/9/80	1466	42.0	1480	3080

In general, the chemical quality of water found in the Lower Floridan Aquifer at the site is of similar quality to that found at the Estech Duette Mine, at

CF Industries Hardee County Mine, and at other locations in the region. The upper and middle sections of the aquifer contain potable water, and the basal portion contains more mineralized water whose concentration increases with depth.

6.1.8 QUALITY ASSURANCE

6.1.8.1 Well Drilling

The drilling program at the proposed mine site was undertaken to provide the data necessary to obtain a CUP from SWFWMD. A plan of study including number, type and location of wells and type of aquifer testing was submitted to and approved by SWFWMD prior to the initiation of drilling. The well drilling specifications met well construction standards set by the FDER, SWFWMD, the American Water Works Association, and the Polk County Construction Code. The drilling contractor was a water well contractor licensed by the State of Florida; the drillers operating at the project site were registered with SWFWMD.

6.1.8.2 Geophysical Well Logging

Wells drilled during the study were geophysically logged by two firms. Each logging tool was calibrated and scaled at the site in accordance with procedures specified by the manufacturer.

6.1.8.3 Aquifer Testing

The aquifer testing program undertaken at the site was included in the plan of study approved by SWFWMD. Water levels were measured by chalked steel tapes and electric tapes and were continuously monitored by water-level recording instruments. The flow rate during the 10-day pumping test was determined by an orifice. The orifice was measured prior to the test and was installed level to ensure the accuracy of the flow data. The flow rate was calculated from an equation verified by field calibration curves (Layne, 1958).

6.1.8.4 Water Quality

The Shallow Aquifer was sampled by a grab technique in February, 1980 and by utilizing a peristaltic pump during the September, 1980 samplings. The shallow well was not evacuated before the February sampling; however, the wells were evacuated one day before the September samplings and the pump intake line was rinsed with distilled water and well water before sample collection from the individual wells. Upper Floridan Aquifer wells along with the Lower Floridan production well were sampled from the discharge of the turbine pumps. Large volumes of water were pumped before sample collection from these wells. Lower Floridan observation wells were also sampled at various depths utilizing a down-hole grab sampler. All samples were transported immediately to the project laboratory facilities in Orlando, Florida for analyses. Conductivity, pH and temperature measurements were performed in the field during the September sampling of the Shallow Aquifer.

The water samples were analyzed in accordance with procedures outlined in "Standard Methods for the Examination of Water and Wastewater," 14th Edition, 1975. In-house laboratory quality control procedures included conducting duplicate and spiked analyses on a minimum of ten percent of the samples collected. An analytical quality assurance program for the groundwater monitoring study was conducted in conjunction with the surface water monitoring study. The quality assurance program included in-house laboratory quality control procedures as well as FDER round-robin tests and EPA standard reference tests.

Laboratory quality assurance audit summaries were prepared by the third-party consultant and were submitted to EPA and Mobil. These quality assurance audits included evaluations of the procedures, techniques and accuracy of the laboratory in performing water quality analyses. All quality assurance data and audit summaries are on file with both EPA and Mobil.

6.2 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

6.2.1 THE NO ACTION ALTERNATIVE

Under the no action alternative groundwater would continue to be used for irrigation, municipal, industrial and domestic supplies in the area of the proposed mine. Seasonal changes in water levels of the Surficial, Lower Floridan and Upper Floridan Aquifers would not be affected. The hydrologic characteristics of the Surficial Aquifer would not be altered, nor would recharge to the Floridan Aquifer change. The quality of groundwater in the region is presently suitable for potable water supplies, industrial processing and irrigation and would not be changed as a result of the no action alternative.

6.2.2 THE ACTION ALTERNATIVES INCLUDING THE PROPOSED ACTION

6.2.2.1 Mining Method Alternatives (See description DEIS 2.2)

Dragline (Mobil's Proposed Action): The dragline method would require a relatively dry pit for effective mining. To attain this condition, dewatering of the Surficial Aquifer would be necessary, temporarily lowering water table levels adjacent to the pit. Based on aquifer properties determined in the baseline study, an average Surficial Aquifer thickness of 25 feet, and an average pit bottom 45 feet below land surface, a drawdown of one foot (using the Dupuit method described in Todd, 1959) is expected 115 feet from the perimeter of the open pit. Perimeter rim ditches identified in Mobil's proposed action would negate off-site drawdowns in the water table aquifer.

The dewatering for dragline mining would affect the recharge to the Floridan Aquifer system as a result of lowering the Surficial Aquifer water table in the vicinity of the mine pit an average of 38 feet. Utilizing the aquifer properties determined in the baseline study, it is calculated that the natural recharge over the project site of three inches per year would be reduced by about 0.1 inch per year as a result of dewatering activities.

Bucket Wheel: The bucket wheel method of mining would require a totally dry pit, a condition difficult to attain during the rainy summer months. Additional dewatering beyond that needed for the dragline would be required. Impacts from the bucket wheel method, other than those associated with dewatering, would be similar to the dragline mining method.

Dredge: The dredge mining method would require flooding of the mining area. Groundwater from the Lower Floridan Aquifer would be used to maintain the necessary water levels in the dredge pit. This increased pumping would serve to further lower the piezometric level in the Lower Floridan Aquifer. During overburden removal, the water level in the pit would be maintained and would, therefore, have no dewatering effect on the Surficial Aquifer. During matrix removal the water level would be lowered and maintained above the top of the matrix, temporarily dewatering the upper zones of the Surficial Aquifer in the immediate vicinity of the dredge basin.

During overburden removal there would be no effect on natural recharge. During ore extraction, however, the reduction in natural recharge for the total site would be about 0.03 inches per year or one-third of that calculated for the dragline mining method.

Mining by dredge would increase turbidity and suspended solids content in the recirculation system. Because leach zone management could not be practiced with this mining method, radioactive particles attached to the suspended solids could result in increased radiation levels in the water recirculation system.

6.2.2.2 Matrix Transfer Alternatives (See description DEIS 2.3)

Pipeline (Mobil's Proposed Action): The matrix would be slurried at the mining area and transferred to the beneficiation plant by pipeline, requiring approximately 18,750 gpm of slurry transport water and 480 gpm of pump seal water. The slurry transport water would be recycled water obtained from the recirculation system. The pump seal water source would be from wells drilled into the Upper Floridan Aquifer, and withdrawal points for this water would change as mining progresses. The changes to the piezometric levels would be temporary, ceasing with the completion of mining.

Conveyor Belt: Transporting the matrix to the beneficiation plant by conveyor belt would involve placement of the matrix onto the conveyor without the addition of water. However, recycled water would still be needed for the conveyor method as washing water once the matrix reaches the beneficiation plant. The quantity of recycled water required for the conveyor belt method of transport would be approximately equivalent to the pipeline transfer method. The pump seal water requirement (480 gpm) would be eliminated because the booster pumps would not be needed.

Truck: Truck transport of the matrix would eliminate the need for pump seal water (480 gpm), but as with conveyor belt transport, overall water requirements would not be reduced due to the need for matrix processing water.

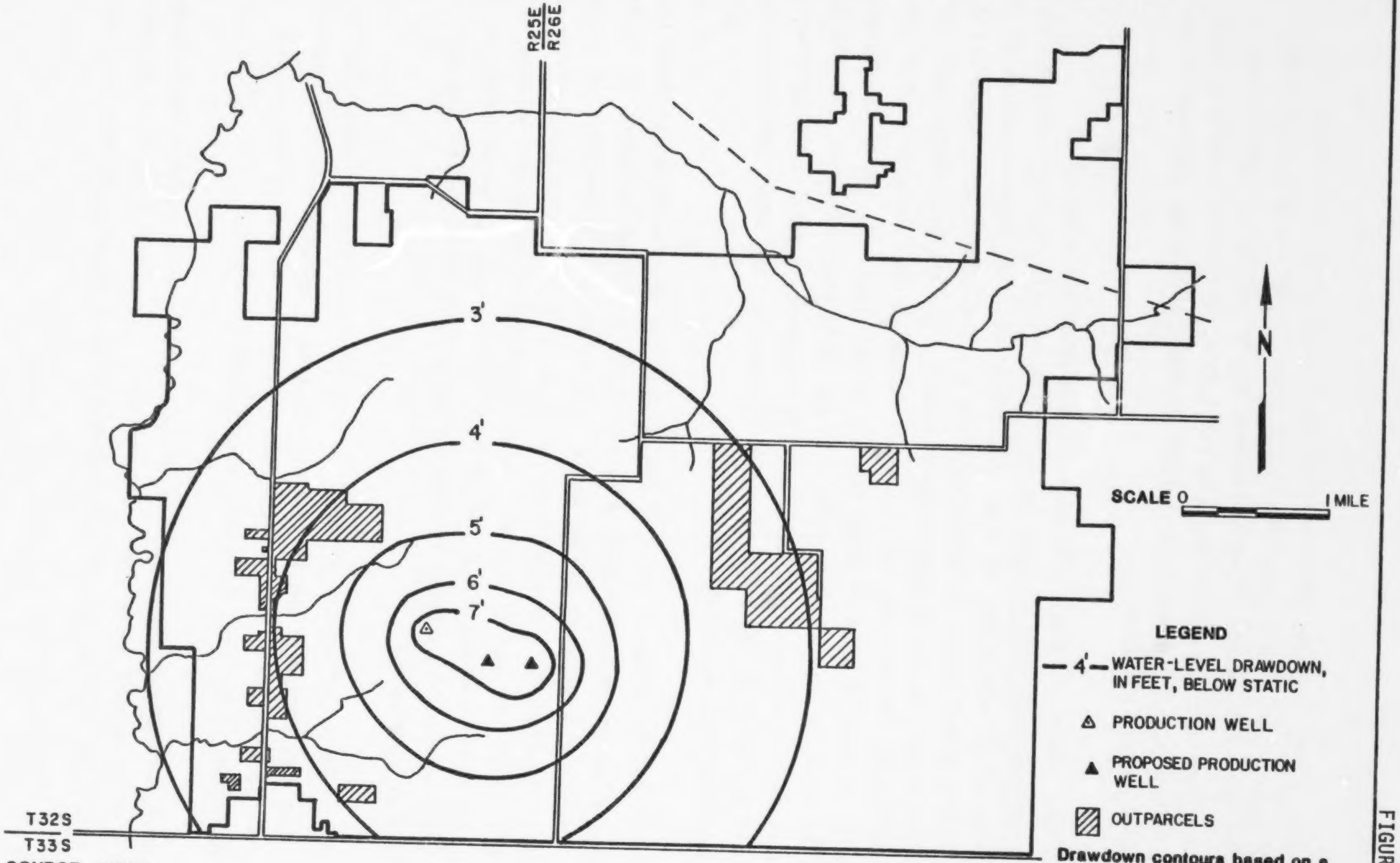
6.2.2.3 Processing Alternatives (See description DEIS 2.4)

Conventional Beneficiation (Mobil's Proposed Action): The conventional beneficiation process would utilize up to 130 mgd of water from the recirculation system, and 15.7 mgd of flotation process water and makeup water obtained from the Lower Floridan Aquifer. This groundwater withdrawal would lower the piezometric level of the Lower Floridan Aquifer during the 25 years the beneficiation plant is in operation. The values for transmissivity and leakance determined for the site during the baseline study were 1,300,000 gpd/ft and 0.002 gpd/ft^3, respectively. Using the more conservative data included in the application for a Consumptive Use Permit (CUP) to SWFWMD, and the pumping rate of 15.7 mgd from three production wells, contours of projected drawdown levels were developed (Figure 6-P). The calculated drawdown in the piezometric surface at the property boundaries would range from a maximum of 4.3 feet to less than one foot. The change in the piezometric surface of the Lower Floridan Aquifer would be temporary. At the end of mining activity, the pumping would cease and the piezometric level should return to premining conditions.

Withdrawals from the artesian groundwater system could potentially cause upward movement of the higher sulfate water located near the bottom of the Lower Floridan Aquifer. The higher sulfate water occurs naturally in and slightly above the evaporite zone. During the 10-day pumping test at the site, an increase in the sulfate concentration of the discharged water was observed. After seven days, the concentration of sulfates stabilized at about 530 mg/l. Throughout the test the chloride concentration remained essentially constant at 12.5 mg/l. Any movement of the high sulfate water, as a result of the continuous groundwater withdrawals, would be noted first in the production wells at the project site. The monitoring required as part of Mobil's CUP from SWFWMD would demonstrate if movement of the high sulfate water were occurring.

Reagents would be added in the flotation process and would be discharged with the sand tailings and waste clays. The excess water from the waste sand and clay disposal areas would drain into the recirculation system from which some seepage into the Surficial Aquifer would occur via the ditches and canals. The impact on Surficial Aquifer water quality is discussed under waste disposal alternatives, beginning on page 6-38.

LOWER FLORIDAN AQUIFER DRAWDOWN PROJECTION



Drawdown contours based on a total pumping rate of 15.7 MGD from three wells.

SOURCE: MOBIL

FIGURE 6-P

Dry Separation: The dry separation method of processing would not utilize the large quantities of water required by the conventional beneficiation method. Due to the small amounts of water required for this method of processing, impacts on the artesian system would be negligible. No chemicals would be used in the beneficiation process; therefore, groundwater quality would not be affected by this alternative.

6.2.2.4 Waste Disposal Alternatives (See description DEIS 2.5)

Conventional Clay Settling Case (Mobil's Proposed Action): Mobil proposes to dispose of the waste sand and clay in conventional clay settling and sand tailing disposal areas. As the mined areas are filled with waste materials or as the wastes are stored above natural grade, a new shallow aquifer would be established. In the clay settling areas (9,683 acres), the elevation of the water table would be at or above the top of the clays. As the clays compact, water would be decanted and returned to the recirculation system, lowering the water table. As the elevation of the fill in the clay settling areas rises above the level of the surrounding Shallow Aquifer, the water level would rise in the adjacent water table system.

In the tailing disposal areas (5,034 acres), the sand would permit rapid drainage, allowing the water table to re-establish at a level dependent on the hydrologic characteristics of the surrounding materials. Groundwater in the Surficial Aquifer would have preferential flow in areas of high permeability such as the sand tailings fill areas. Sand tailings disposal areas, which do not retain water like waste clay, would have little impact on water levels in the Surficial Aquifer, tending to maintain levels similar to those found in natural conditions.

The greatest consumption of water in the mining operation is water that becomes entrained with the waste clays and sand. Approximately 11.6 mgd of water are entrained in the waste clay disposal areas and 1.7 mgd of water are entrained in the sand tailings disposal areas.

As waste disposal progresses, recharge to the artesian aquifer would decrease as the number of waste clay areas increase. Using the final average above-grade clay fill height of 32.8 feet and 9,683 acres of clay settling area, the calculated recharge to the artesian aquifer from the clay settling areas would be 0.1 inches/year. This would reduce the weighted average recharge for the total site from three inches to about 1.6 inches per year.

Water in the recirculation system may contain contaminants from contact with the ore matrix and from the reagents used in the flotation process. Many of these contaminants would become entrained with the clays or would be biologically degraded. Seepage from the clay settling areas and the sand tailings disposal areas would average 2.7 mgd and would result in minor changes of water quality in the Surficial Aquifer. A comparison of the quality of Surficial Aquifer water to that of the water quality of projected clay settling area supernatant is presented in Table 6-14. The clays in the clay settling areas should form a natural seal, reducing seepage from these areas.

Sand/Clay Cap Case: The sand/clay cap waste disposal case is similar to the conventional clay settling disposal case except that a five foot mixture of sand/clay (4:1) material would be placed on 7,580 acres of clay settling areas. This method of waste disposal would have impacts on the groundwater system similar to that of the proposed action.

Sand/Clay Mix Case: The sand/clay mix case would have 3,512 acres of sand/clay mix areas, 3,185 acres of clay capped with sand/clay mix and 1,642 acres of clay settling areas. The two to one mixture of sand and clay does not significantly increase the permeability of the mixture from that of clay. Seepage from the sand/clay mix waste disposal areas into the Surficial Aquifer would be increased slightly. The amount of water retained in the waste disposal areas would be reduced when the clays are mixed with sand. For the sand/clay mix case, this reduction would be approximately half a million gallons per day relative to the conventional case (from 11.6 mgd to 11.1 mgd).

Overburden/Clay Mix Case: The overburden/clay mix disposal case would contain 5,492 acres of sand/clay mix (2:1) areas and 2,847 acres of clay settling areas capped with sand/clay mix. This waste disposal alternative would have potential impacts on the groundwater system similar to the sand/clay mix waste disposal alternative.

6.2.2.5 Reclamation Alternatives (See description DEIS 2.6)

Conventional Clay Settling Plan (Mobil's Proposed Action): During mining operations, the waste products of the beneficiation process (clays and sand tailings) would be disposed of in mine cuts and above-ground storage areas. With the completion of mining operations and waste disposal activities, a shallow groundwater level would be established in these waste materials dependent on the nature of the waste products in conjunction with topography. The clay materials in clay disposal areas (9,683 acres) would retain water at or near the top of the clays. In the sand tailings disposal areas (5,034 acres), the sand would allow water to drain to a level dependent on the hydrologic characteristics of the sand and adjacent materials. In the proposed reclamation plan, the sand tailings disposal areas would primarily be along existing streams. This would provide transitional zones between high water levels of the waste clay settling areas and the streams.

The premining flow of water through the Surficial Aquifer would change as a result of the formation of clay disposal areas. After reclamation, groundwater in the Surficial Aquifer that would have moved through the site would be blocked and diverted by the 9,683 acres of waste clay. This water would become additional base flow to streams near the mine, thereby increasing evapotranspiration and raising the head in the water table upgradient of the site and recharge at that point to the artesian system.

The conventional reclamation plan would reduce recharge to the artesian aquifer from the South Fort Meade site as a result of the disposal of waste clays which have a lower permeability than the premining materials. A reduction in recharge to 0.1 inches/year at the clay storage areas was calculated using the hydrologic properties from the baseline study and an estimated waste clay permeability of 0.0002 gpd/ft^2 (Bromwell, 1976). Although the water level in the Shallow Aquifer would be increased an average of 32.8 feet, a 1.4 inch/year average reduction of the recharge to the artesian aquifer would still occur over the property (i.e., from 3 to 1.6 inches/year).

Water from the waste disposal areas could potentially enter the Surficial Aquifer system. The sand tailings and waste clays would contain naturally occurring contaminants from the phosphate matrix and residual reagents used in the flotation process. Groundwater withdrawn from the Surficial Aquifer in reclaimed areas may contain some of these contaminants.

Sand/Clay Cap Plan: The sand/clay cap reclamation plan would have 7,580 acres of above-clay clay settling areas capped with five feet of sand/clay mix (4:1) material, 590 acres of above-grade clay settling basins capped with overburden, 1,513 acres of below-grade clay settling basins, and 5,079 acres of sand tailings fill areas capped with overburden. The basin sizes and configurations would be approximately the same as the proposed conventional plan.

The sand/clay mix material at a 4:1 ratio would have a permeability greater than the clay alone; therefore, vertical and horizontal water movement in the five-foot sand/clay cap would be greater than the water movement in the clay. This would allow a perched water table to be established about five feet below the surface of the sand/clay cap areas (7,580 acres).

The below-grade clay settling areas (1,513 acres) would be developed as wetlands. The water table level in these areas would be near the surface. The 590 acres of above-grade clay settling basins capped with overburden would have a perched water table in the overburden cap.

The sand tailings fill areas (5,070 acres) would have a high permeability allowing rapid drainage and establishment of the Surficial Aquifer water table at a level dependent upon the adjacent materials. As with the proposed conventional plan, the sand tailings fill areas would be primarily located along existing stream channels and would provide transitional zones between the high water table levels of the above-grade clay settling areas and the streams.

The sand/clay cap reclamation plan would alter the flow and potentially alter the quality of the Surficial Aquifer in essentially the same manner as the conventional reclamation plan. The reduction in recharge to the artesian aquifer would be similar to that of the conventional plan.

Sand/Clay Mix Plan: The sand/clay mix plan would have 3,512 acres of sand/clay mix (2:1), 3,185 acres of conventional clay settling areas with sand/

clay mix (2:1) cap, 2,095 acres of below-grade clay settling areas, 1,642 acres of above-grade clay settling areas, 1,740 acres of overburden fill and 3,020 acres of sand tailings fill with overburden cap. The dike configurations would be similar to those of the proposed action.

The permeability of the 2:1 sand/clay mix material would be slightly greater than that of clay alone, resulting in a small increase in recharge to the artesian aquifer for the sand/clay mix plan compared to the proposed conventional plan. The water retention capabilities of the reclaimed sand/clay mix materials would be essentially the same as clay. The re-establishment of the water table in the 3,512 acres of sand/clay mix areas would be dependent on the hydrologic gradient of the sand/clay mix and the adjacent materials.

The 3,185 acres of clay settling areas with sand/clay mix (2:1) cap would develop a perched water table about five feet below the surface at the interface of the clay and sand/clay mix material.

The above-grade and below-grade clay settling areas would retain water at or near the surface. These areas would reduce natural recharge as described for clay settling areas under the proposed action.

The overburden fill areas and sand tailing fill areas would have high permeabilities that would allow rapid drainage. The effects of these areas on the groundwater system would be the same as those described for the sand tailings fill areas under the conventional clay settling plan.

The sand/clay mix reclamation plan would have impacts on the regional Surficial Aquifer and local Surficial Aquifer water quality similar to that of the proposed conventional plan.

Overburden Mix Plan: The overburden mix plan would have 5,492 acres of sand/clay mix (2:1) areas, 2,847 acres of clay settling areas with sand/clay mix (2:1) cap, 2,095 acres of below-grade clay settling areas, 1,740 acres of overburden fill areas, and 3,020 acres of sand tailings fill areas capped with overburden. The dike configuration would be the same as the sand/clay mix plan.

The 5,492 acres of sand/clay mix areas would have the same impacts on the groundwater system as the sand/clay mix areas described under the sand/clay mix plan. The sand/clay mix (2:1) areas would have a permeability slightly greater than clay; therefore, the effects on the groundwater system would be slightly greater natural recharge than for clay settling areas. The amounts of below-grade clay settling areas, sand tailing fill areas and overburden fill areas are equivalent to the sand/clay mix plan acreages. Therefore, the overburden mix plan would have approximately the same impacts on groundwater as the sand/clay mix plan, except there would be slightly greater natural recharge.

6.2.2.6 Water Source Alternatives (See description DEIS 2.7)

Groundwater (Mobil's Proposed Action): During the 25 years of mining activity, water would be withdrawn for water supplies from the Lower Floridan Aquifer (15.7 mgd) and from the Upper Floridan Aquifer (0.731 mgd), and for dewatering purposes from the Surficial Aquifer. The withdrawals would lower the water level in both the artesian and shallow aquifers, and would alter the recharge from the shallow to the artesian aquifer. The effect of these groundwater withdrawals has been discussed under previous sections (Mining Methods, Matrix Transfer and Processing). The effects of the withdrawal rates have been evaluated by SWFWMD through CUP No. 205403 and the proposed withdrawal rates were approved.

Recharge to the artesian aquifer from the Surficial Aquifer would be affected both by lowering the water level in the artesian aquifer by pumpage and by dewatering the Surficial Aquifer. The 15.7 mgd of groundwater withdrawn from the Lower Floridan Aquifer would lower the piezometric surface beneath the site an average of 3.3 feet. This drawdown would cause an increase in recharge to the artesian system underlying the total area of the proposed mine site of about 0.2 inches/year. A local reduction in recharge due to dewatering for mining operations would occur in the areas being mined. Calculations using the aquifer characteristics determined in the baseline study indicate that lowering the water table 38 feet by dewatering would decrease the recharge to the artesian aquifer 0.7 inches/year in the area of the mining pit. The changes in recharge due to groundwater withdrawals and pit dewatering are

Surface Water: If surface water were used for water supply, the piezometric surface and water quality of the artesian aquifer would not be affected by withdrawals of groundwater. Dewatering operations would be required to keep the mine pit dry; therefore, the impacts to the water level and water quality of the Surficial Aquifer would be the same as described for the proposed action. When active mining ceases, the net impact on recharge would be the same as for the proposed action.

6.3 REFERENCES

Borden Chemical Company, Development of Regional Impact Application for Development Approval, 1975.

Bouwer, H., 1978. Groundwater Hydrology, McGraw Hill, New York, New York.

Bromwell, L.G., 1976. Dewatering and Stabilization of Waste Clays, Slimes and Sludges. Florida Phosphatic Clays Research Project.

Cooper, H.H., Jr., Bredehoeft, J.D., and Papadopulos, I.S., 1967. Response of a Finite Diameter Well to an Instantaneous Charge of Water, Water Resource Research, 3(2).

Ferris, S.G., and Knowles, D.B., 1963. The Slug-Injection Test for Estimating the Coefficient of Transmissivity of an Aquifer, in: Methods of Determining Permeability and Transmissibility and Drawdown, U.S. Geological Survey Water Supply Paper 1536-I.

Kruseman, G.P., and Ridder, N.A., 1970. Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.

Layne and Bowler, Inc., 1958. Measurement Of Water Flow Through Pipe Orifice With Free Discharge, Bulletin 501.

Parker, G.G., Ferguson, G.E., Love, S.K., et al., 1955. Water Resources of Southeastern Florida. Geological Survey Water-Supply Paper No. 1255.

Southwest Florida Water Management District, 1977. Water Use Plan, Draft II.

Todd, D.K., 1959. Ground Water Hydrology. John Wiley and Sons, Inc., New York, New York.

U.S. Environmental Protection Agency, 1978. Central Florida Phosphate Industry Areawide Impact Assessment Program, Volume V: Water, prepared by Texas Instruments, Inc.

Viesmann, W., et al., 1972. Introduction to Hydrology, Intext Educational Publishers, New York/London.

Walton, W.C., 1970. Groundwater Resource Evaluation, McGraw Hill, New York, New York.

Wilson, W.E., 1977. Groundwater Resources of DeSoto and Hardee Counties, Florida, U.S. Geological Survey Report of Investigation, No. 83.

Wilson, W.E. and Gerhart, J.M., 1980. Simulated Effects of Groundwater Development on Potentiometric Surface of the Floridan Aquifer, West-Central Florida, U.S. Geological Survey. Water Resources Investigations Open Tile Report 79-1271.

TABLE 6-1

CONSTRUCTION DETAILS - SHALLOW AQUIFER WELLS

		Casing		Screen		
Well No.	Total Depth Drilled (feet)	Diameter (inches)	Depth (feet)	Slot Diameter (inches)	Size (inches)	Setting (feet)
SA-1	55	8	50	8	0.035	50-55
SA-2	32	8	27	8	0.035	27-32
SA-3	32	8	27	8	0.035	27-32
SA-4	29	8	24	8	0.035	24-29
SA-5	24	8	19	8	0.035	19-24
SA-6	24	8	19	8	0.035	19-24
SA-7	24	8	19	8	0.035	19-24
SA-9	12	8	7	8	0.035	7-12
SA-10	19	8	14	8	0.035	14-19
SA-11	21	8	16	8	0.035	16-21

SOURCE: STUDY DATA

TABLE 6-2

CONSTRUCTION DETAILS - UPPER FLORIDAN WELLS

Well No.	Total Depth Drilled (feet)	Casing Diameter (inches)	Casing Depth (feet)	Open Hole (feet)
UF-1	243	8	218	218-243
UF-2	230	8	205	205-230
UF-3	230	8	205	205-230
UF-4	230	8	190	190-217
UF-6	220	8	190	190-220
UF-7	230	8	200	200-230
UF-9	235	8	200	200-235
UF-10	250	8	220	220-250
UF-11	222	8	190	190-222

SOURCE: STUDY DATA

TABLE 6-3

CONSTRUCTION DETAILS - LOWER FLORIDAN WELLS

Well No.	Total Depth Drilled (feet)	Casing Diameter (inches)	Casing Depth (feet)	Open Hole (feet)
LF-5	1200	8	315	315-1200
LF-6	1200	32	45	
		24	160	
		18	316	316-1002
LF-8	1200	8	315	315-1200
LF-11	1466	8	326	326-1466
LF-12	1400	8	190	
		5	340	340-1000
LF-13	1200	8	315	315-1200

SOURCE: STUDY DATA

TABLE 6-4

AQUIFER CHARACTERISTICS OF LOWER FLORIDAN WELLS OBTAINED FROM LF-6 TEN-DAY PUMPING TEST

Well No.	Transmissivity (gpd/ft.)		Storativity*		Leakance (gpd/ft^3)	
	HIPM	HJMCM	HIPM	HJMCM	HIPM	HJMCM
LF-5	1,444,000	1,473,000	.0001	.0002	.0016	.0006
LF-8	1,381,000	1,146,000	.0001	.0001	.0012	.0011
LF-11	1,274,000	1,199,000	.0003	.0003	.0059	.0043
LF-12	974,000	781,000	.0045	.0070	.0450	.0450
LF-13	1,279,000	1,052,000	.0001	.0002	.0018	.0022

HIPM - Hantush Inflection-Point Method

HJMCM - Hantush-Jacob Matching-Curve Method

* Expressed as a ratio where the volume of water released is divided by the volume of water defined by the change in piezometric head for an artesian aquifer, and is therefore unitless.

SOURCE: STUDY DATA

TABLE 6-5

CHEMICAL ANALYSIS OF WATER FROM THE SHALLOW AQUIFER[1]

Constituent	Florida Groundwater[6] Class 1-8 Standards	Drinking Water Standard[2]	SA-2	SA-3	SA-4	SA-5	SA-6		SA-7	SA-9	SA-10	SA-5
			9-26-80	9-26-80	9-26-80	9-25-80	2-28-80	9-25-80	9-26-80	9-25-80	9-25-80	9-25-80
Conductivity (umho)/cm)[3]	-	-	55	225	180	480	190	135	60	90	170	225
pH[3]	-	6.5-8.5 R	5.50	5.95	6.70	8.45	7.50	5.50	5.65	6.45	6.45	6.15
Temperature (°C)[3]	-	-	27	29	29	28	-	27	26	26	28	29
Acidity ($CaCO_3$)	-	-	8	7	3	5	6	14	7	6	7	11
Total Alkalinity ($CaCO_3$)	-	-	12	22	75	161	72	31	10	25	39	67
Total Solids ($CaCO_3$)	-	-	1470	191	118	348	138	104	148	716	120	176
Total Dissolved Solids	-	500 R	-	-	-	-	134	-	-	-	-	-
Color (PCU)	-	15 R	1000	150	5	70	25	30	200	500	15	200
Fluoride (F)	1.5	1.4-2.8 M	0.12	0.46	0.28	3.8	0.49	0.50	0.30	0.43	0.53	0.28
Total Phosphorus	-	-	13.4	0.36	0.33	0.45	0.75	1.10	1.04	1.33	0.86	0.15
Ortho-Phosphate (PO_4)	-	-	0.38	0.20	0.27	0.42	0.70	1.02	0.34	0.91	0.59	0.03
Organic Nitrogen	-	-	0.56	0.15	0.04	1.78	0.3[4]	0.77	0.49	0.69	0.12	0.16
Ammonia (NH_3)	-	-	0.28	0.20	0.26	3.1	0.11	0.14	<0.10	<0.10	0.21	0.48
Nitrate (NO_3)	10.0	10.0 M	<0.02	0.13	<0.02	<0.02	<0.1	<0.02	0.4	0.25	2.1	<0.02
Nitrite (NO_2)	-	-	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silica (SiO_2)	-	-	10.7	15.0	19.7	6.9	12.8	16.1	8.2	9.6	9.1	7.8
Sulfate	-	250 R	<1.0	35.4	2.5	19.6	7.9	1.9	1.0	6.6	11.5	9.8
Total Organic Carbon (mg C/l)	-	-	12.8	6.5	1.0	23.2	63.8	1.3	2.3	6.5	2.7	7.6
Aluminum (AL)	-	-	16.7	3.90	<0.40	0.66	0.57	0.88	7.69	2.5	1.20	1.20
Arsenic (As)	0.05	0.05 M	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Barium (Ba)	1.0	1.0 M	0.2	<0.1	<0.1	<0.01	0.31	<0.01	<0.01	0.3	<0.01	<0.01
Cadmium (Cd)	0.01	0.01 M	0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	0.01	0.01	0.01
Calcium (Ca)	-	200 R	4.41	9.85	10.9	41.7	22.2	9.60	4.73	10.1	15.7	13.1
Chromium (Cr)	0.05	0.05 M	<0.04	<0.04	<0.04	<0.04	<0.05	<0.04	<0.04	0.06	<0.04	<0.04
Copper (Cu)	-	1.0 R	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Iron (Fe)	-	0.3 R	3.45	1.58	0.11	0.10	1.95	2.04	1.61	4.59	0.08	6.28
Lead (Pb)	0.05	0.05 M	0.2	<0.01	0.1	<0.01	0.07	<0.01	0.1	<0.1	<0.01	<0.01
Magnesium (Mg)	-	125 R	8.83	5.04	9.93	1.34	6.2	3.47	1.66	2.76	4.81	5.35
Mercury (Hg)	0.002	0.002 M	<0.001	<0.001	<0.001	<0.001	<0.001	<0.006	<0.001	<0.001	<0.001	<0.001
Nickel (Ni)	-	-	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Potassium (K)	-	-	0.878	0.890	0.728	3.39	0.960	0.372	0.388	3.54	0.995	1.61
Selenium (Se)	0.01	0.01 M	<0.01	<0.01	<0.01	<0.01	<0.004	<0.01	<0.01	<0.01	<0.01	<0.01
Silver (Ag)	0.05	0.05 M	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sodium (Na)	-	200 R	63.1	38.0	23.6	73.8	11.4	18.4	24.5	21.5	14.8	36.7
Strontium (Sr)	-	-	0.578	0.58	<0.01	1.86	0.76	<0.10	0.33	1.67	0.31	0.54
Chloride (Cl)	-	250 R	-	13.0	-	-	13.0	-	-	-	-	-
Pesticide Scan	-	-	ND[5]	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oil and Grease	-	-	-	-	-	-	<0.2	-	-	-	-	-
Total Hardness ($CaCO^3$)	-	-	-	-	-	-	88	-	-	-	-	-
Gross Alpha PiCo Curries/l	15.01	15.0	26.3 ± 7.3	<5.4	<2.3	6.6 ± 6.3	<0.4	-	<4.1	97 ± 16.7	<0.9	4.8 ± 4.6
Radium 226	-	-	9.8 ± 0.4	1.1 ± 0.1	-	1.8 ± 0.2	-<0.4	-	-	14.6 ± 0.5	-	1.1 ± 0.1

All constituents are in mg/l except pH and those noted.

[1] Well SA1 was not sampled due to depth of water.

[2] Environmental Protection Agency Primary and Secondary Standards (Partial List); M (Mandatory) R (Recommended).

[3] Field measurements, except 2-28-80 sample.

[4] Total Kjeldahl Nitrogen.

[5] None detected.

[6] Includes all groundwater with total dissolved solids less than 10,000 mg/l, FAC Chapter 17.3.

SOURCE: STUDY DATA

TABLE 6-6

CHEMICAL ANALYSIS OF GROUNDWATER AT THE SOUTH FORT MEADE SITE

Constituents	Florida Groundwater Class 1-B Standards[a]	EPA Drinking Water Standard[b]	Shallow Aquifer[c]	Upper Floridan Aquifer Well UF-10 (Sampled 2-29-80)	Lower Floridan Aquifer Well LF-6 (Sampled 2-15-80)
Conductivity (µmho/cm)	-		-		
pH	-	6.5-8.5 R	181	480	1130
Acidity ($CaCo_3$)	-	-	5.5-8.5	7.5	7.6
Total Alkalinity ($CaCo_3$)	-	-	7	3	13
Total Hardness ($CaCO_3$)	-	-	51	156	130
Total Solids	-	-	88	204	648
Total Dissolved Solids (TDS)	-	500 R	500	328	966
Color (PCU)	-	15 R	134	316	961
Fluoride (F)	1.5	1.4-2.4 M	220	30	5
Total Phosphorus	-	-	0.72	1.8	0.60
Ortho-Phosphate	-	-	1.98	0.02	0.02
Total Kjeldahl Nitrogen (TKN)	-	-	0.49	0.01	0.01
Ammonia (NH_3)	-	-	0.51	0.4	0.3
Nitrate (NO_3)	44	44 M	0.50	0.33	0.16
Nitrite (NO_2)	-	-	0.28	0.3	<0.1
Silica (SiO_2)	-	-	<0.01	<0.01	<0.01
Sulfate (SO_4)	-	250 R	11.6	26.6	23.3
Total Organic Carbon (TOC)	-	-	9.4	63.7	530
Aluminum (Al)	-	-	12.8	76.2	60.6
Arsenic (As)	0.05	0.05 M	3.5	0.19	0.29
Barium (Ba)	1.0	1.0 M	<0.05	<0.004	<0.004
Cadmium (Cd)	0.01	0.01 M	0.01	<0.1	<0.1
Calcium (Ca)	-	200 R	<0.01	0.02	0.10
Chromium (Cr)	0.05	0.05 M	14.2	37.4	117.6
Copper (Cu)	-	1.0 R	<0.04	<0.05	<0.05
Iron (Fe)	-	0.3 R	<0.03	0.07	0.03
Lead (Pb)	0.05	0.05 M	2.18	0.98	0.14
Magnesium (Mg)	-	125 R	<0.1	<0.02	<0.04
Mercury (Hg)	0.002	0.002 M	4.94	24.1	56
Nickel (Ni)	-	-	<0.001	0.002	0.002
Potassium (K)	-	-	<0.06	<0.06	<0.04
Selenium (Se)	0.01	0.01 M	1.06	4.9	10.4
Silver (Ag)	0.05	0.05 M	<0.01	<0.004	<0.004
Sodium (Na)	-	200 R	<0.03	<0.03	<0.03
Strontium (Sr)	-	-	32.6	24.2	8.0
Chloride (Cl)	-	250 R	0.68	13.8	66.0
Pesticide Scan	-	-	0.13	17.6	13.1
Oil and Grease	-	-	ND 2	ND 2	ND 2
Radium -226 (pCi/l)	-	5	-	<0.2	<0.2
Gross Alpha (pCi/l)	15	15	<1-14.6	4.4	2.3
			<0.4-97	4.8	34

All constituents are given in mg/l except pH and those noted.

ND - None Detected

[a] FAC Chapter 17-3, includes all groundwater with total dissolved solids less than 10,000 mg/l.

[b] EPA Primary and Secondary Standards (Partial List): M (Mandatory), R (Recommended).

[c] Mean value of 10 samples collected from 9 shallow wells February and September 1980.

SOURCE: STUDY DATA

TABLE 6-7

ANALYSES OF WATER SAMPLES COLLECTED BELOW A DEPTH OF 800 FEET DURING THE REVERSE-AIR DRILLING OF THE LOWER FLORIDAN WELLS

Well No.	Date Sampled	Depth* (feet)	Chloride (mg/l)	Sulfate (mg/l)	Total Dissolved Solids (mg/l)	Conductivity (mhos/cm)
LF-5	12/17/79	800	14.8	74	306	430
LF-5	12/17/79	900	11.0	244	550	720
LF-5	12/19/79	1000	12.9	326	676	875
LF-5	12/29/79	1100	12.0	261	592	755
LF-5	12/29/79	1200	12.0	271	574	775
LF-6	10/25/79	800	12.0	39	280	-
LF-6	10/26/79	900	12.3	144	400	-
LF-6	10/30/79	1000	11.5	196	440	-
LF-6	10/31/79	1100	12.5	324	640	-
LF-6	10/31/79	1200	16.1	1333	1960	-
LF-8	11/17/79	800	14.8	100	306	450
LF-8	11/18/79	900	15.7	63	470	410
LF-8	11/18/79	1000	15.7	148	486	530
LF-8	11/19/79	1100	14.8	174	406	520
LF-8	11/20/79	1200	15.7	258	564	750
LF-11	12/05/79	800	14.8	64	268	390
LF-11	12/06/79	900	14.8	68	212	400
LF-11	12/10/79	1000	14.8	76	296	410
LF-11	12/11/79	1100	15.7	146	406	530
LF-11	12/13/79	1200	13.9	521	920	1070
LF-12	10/18/79	800	15.7	93	318	390
LF-12	10/18/79	900	14.8	52	298	400
LF-12	10/18/79	1000	13.9	89	290	490
LF-12	10/22/79	1100	13.9	52	302	425
LF-12	10/23/79	1200	13.9	181	758	690
LF-13	11/14/79	800	12.9	208	500	610
LF-13	11/14/79	900	13.9	217	476	615
LF-13	11/14/79	1000	13.9	264	578	735
LF-13	11/15/79	1100	13.9	271	602	740
LF-13	11/16/79	1200	15.7	1310	2158	2100

* Total well depth at time of sampling. Water samples represent a blend of water from the total open-hole interval below the inner casing depths of approximately 300 feet.

- Data not available

SOURCE: STUDY DATA

TABLE 6-8

ANALYSES OF WATER SAMPLES COLLECTED DURING THE REVERSE-AIR DRILLING OF WELL LF-12

Date Sampled	Depth* (feet)	Chloride (mg/l)	Conductivity (μmhos/cm)
10/23/79	1140-1150	9.8	460
10/23/79	1220	6.9	570
10/23/79	1230	6.3	560
10/23/79	1270	4.6	950
10/24/79	1330-1340	14.9	2600
10/24/79	1330	12.6	1600
10/24/79	1360-1370	14.4	2400
10/24/79	1399	16.7	2900
10/25/79	1399	15.5	2900

---

* Total well depth at time of sampling. Water samples represent a blend of water from the total open-hole interval below the casing set at a depth of 340 feet.

SOURCE: STUDY DATA

TABLE 6-9

ANALYSIS OF THIEF SAMPLE FROM WELL LF-12 AT A DEPTH OF 1400 FEET

Constituent*	Well LF-12 (1/80)
pH	7.2
Iron (Fe)	0.442
Sulfate (SO_4)	1645
Total Hardness ($CaCo_3$)	2091
Total Dissolved Solids	3072
Conductivity (μmhos/cm)	2900

* All constituents are given in mg/l except pH and conductivity as noted.

SOURCE: STUDY DATA

TABLE 6-10

ANALYSES OF WATER SAMPLES COLLECTED FROM WELL LF-6 DURING THE 10-DAY FLORIDAN AQUIFER TEST

	DATE SAMPLED* (Time in minutes since pumping began)									
Constituent	2-5-80 (120)	2-7-80 (2940)	2-9-80 (5820)	2-12-80 (10140)	2-12-80 (10840)	2-13-80 (11580)	2-13-80 (12265)	2-14-80 (13026)	2-14-80 (13725)	2-14-80 (14373)
pH	7.5	7.4	7.3	7.2	7.3	7.2	7.3	7.2	7.3	7.2
Iron	.06	.05	.05	.07	.04	.08	.06	.13	.04	.15
Sulfate (SO_4)	255	369	428	493	514	524	524	533	533	524
Chloride (Cl)	12	12	12	12.5	12.5	13.0	12.5	12.5	12.5	13.0
Total Hardness ($CaCO_3$)	354	401	436	481	442	491	515	472	473	484
Total Dissolved Solids	588	720	812	972	996	1028	1024	1012	984	996
Conductivity (μmhos/cm)	790	923	1022	997	1000	1015	1031	1028	1037	1042
Bicarbonate Alkalinity ($CaCO_3$)	123	130	131	128	128	128	127	127	129	127
Total Alkalinity ($CaCO_3$)	123	130	131	128	128	128	127	127	129	127

All constituents are in mg/l except pH and conductivity as noted.

* Samples collected from discharge pipe. Well pumped at 4500 gpm.

SOURCE: STUDY DATA

TABLE 6-11

ANALYSES OF THIEF SAMPLES COLLECTED AT A DEPTH OF 1200 FEET

Constituent	Well LF-8 (2-29-80)	Well LF-11 (2-29-80)	Well LF-13 (2-29-80)
Conductivity (μmhos/cm)	2500	2640	2850
Total Hardness ($CaCO_3$)	1790	1960	2040
Total Dissolved Solids	2580	2946	3038
Chloride	19.6	22.5	22.5
Sulfate	1215	1471	1556
Iron	0.43	0.75	0.49

All constituents are in mg/l except as noted.

SOURCE: STUDY DATA

TABLE 6-12

ANALYSES OF WATER SAMPLES COLLECTED FROM WELL LF-6 DURING THE 3-DAY FLORIDAN AQUIFER TEST

Time Since Pumping* Began (minutes)	Chloride (mg/l)	Sulfate (mg/l)	Total Dissolved Solid (mg/l)
240	12.6	343	740
480	12.3	353	762
720	12.6	374h	742
960	12.6	378	740
1200	12.6	378	766
1440	12.6	375	786
1680	12.8	335	808
1920	12.8	368	816
2160	11.7	364	834
2400	11.8	396	816
2640	10.6	375	840
2880	11.3	409	822
3120	13.3	395	800
3360	13.7	390	774
3600	13.3	403	786
3840	13.3	417	788
4080	13.1	421	810
4320	13.8	423	782

---

* Samples collected from discharge pipe. Well pumped at 4500 gpm.

SOURCE: STUDY DATA

TABLE 6-13

ANALYSES OF WATER SAMPLES COLLECTED DURING THE DEEPENING OF WELL LF-11

Date	Depth[1] (feet)	Chloride (mg/l)	Sulfate (mg/l)	Total Dissolved Solids (mg/l)
6/11/80	1000 [2]	13.5	117	440
6/12/80	1100 [2]	12.9	120	466
6/12/80	1200 [2]	12.4	227	596
6/14/80	1300 [3]	12.4	444	954
6/14/80	1400 [3]	12.4	394	820
6/15/80	1466 [3]	14.5	1038	2066

---

[1] Samples represent a blend of water from the total open-hole interval below the inner casing of 326 feet.

[2] Samples collected as drilling tools were lowered to the completed well depth of 1200 feet.

[3] Samples collected during the reverse-air drilling below 1200 feet.

SOURCE: STUDY DATA

TABLE 6-14

COMPARISON OF THE WATER QUALITY OF SHALLOW AQUIFER WATER TO TYPICAL VALUES IN CLAY SETTLING AREA SUPERNATANT

Constituents[a]	Surficial Aquifer[b]	Clay Settling Area Supernatant[c]
pH, pH units	5.5-8.5	7.8
Specific Conductance, mhos/cm	181	523
Total Dissolved Solids	134	348
Calcium	<0.04	57
Magnesium	4.94	22
Sodium	32.6	18
Potassium	1.06	1.3
Bicarbonate	-	112
Sulfate	9.4	144
Chloride	13	17
Iron	2.18	0.119
Silica	11.6	2.5
Fluoride	0.72	2.0
Nitrate (NO_3)	0.28	4.7
Phosphorus	1.98	0.09
Radium-226, pCi/l	<1-14.6	0.67

---

[a] Units are mg/l unless otherwise noted.

[b] Average of analyses from Shallow Aquifer wells on the South Fort Meade site, 2/28/80 and 9/25/80.

[c] Lamont, et al. 1975. Characterization Studies of Florida Phosphate Slimes.

7.0 SURFACE WATER

7.1 THE AFFECTED ENVIRONMENT

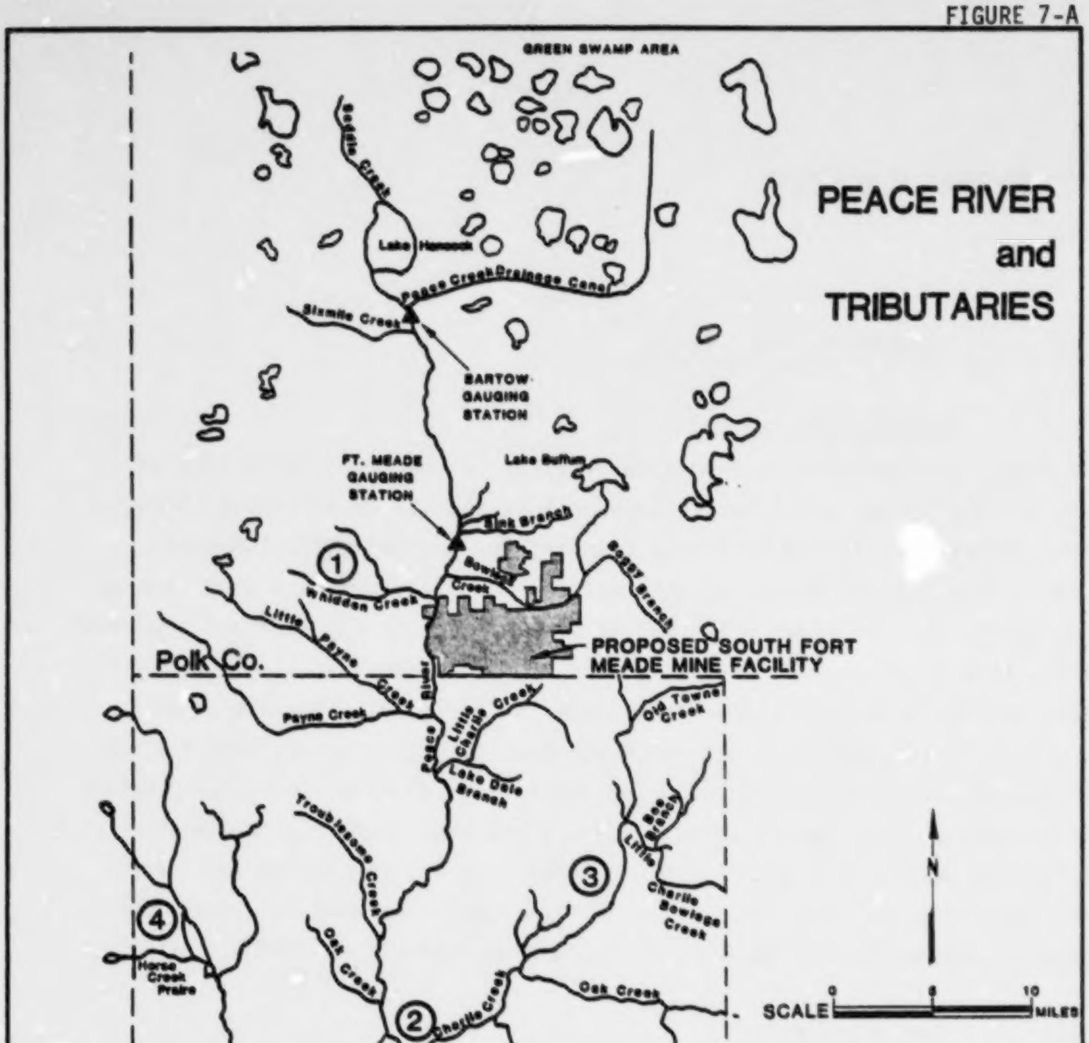
7.1.1 REGIONAL DESCRIPTION

The Peace River originates from several lakes in the Green Swamp area of central Polk County and flows in a general southwesterly direction through Polk, Hardee, DeSoto and Charlotte Counties for approximately 105 miles, entering the Gulf of Mexico at Charlotte Harbor (Figure 7-A). Under average flow conditions the river width varies from 60 feet to 200 feet and the depth varies from 1.5 feet to 10 feet. River flows vary considerably with high flows typically occurring from late summer to early fall, and low flows occurring in the spring during March and April; these flows reflect the influence of precipitation cycles. The Peace River drainage basin encompasses approximately 2,300 square miles. Mobil's proposed South Fort Meade Mine site is located within this drainage basin. Point source discharges and runoff from agricultural, silvicultural and recreational land uses influence the quantity and quality of water in this drainage basin (EPA, 1978).

7.1.2 SITE DESCRIPTION

The project site extends along 4.5 miles of the east bank of the Peace River, directly north of the Polk-Hardee County line. Bowlegs Creek, a major tributary to the Peace River, flows through the northeast section of the proposed mine site and enters the Peace River north of the site. Seven small on-site tributaries contribute to Bowlegs Creek's flow. Three minor tributaries (Stephens Branch, Gurr Run, and Gilshey Branch) flow directly into the Peace River from the project site. These tributaries and their associated drainage basins are illustrated in Figure 7-B. The Bowlegs Creek drainage basin, totaling 59 square miles, includes 7,061 acres or 43 percent of the project site. Land in this basin is used primarily as pasture and woodlands, while the less dominant land uses are citrus production and phosphate mining. There are no significant population centers or point source discharges in this basin. Three small tributaries flow directly into the Peace River and

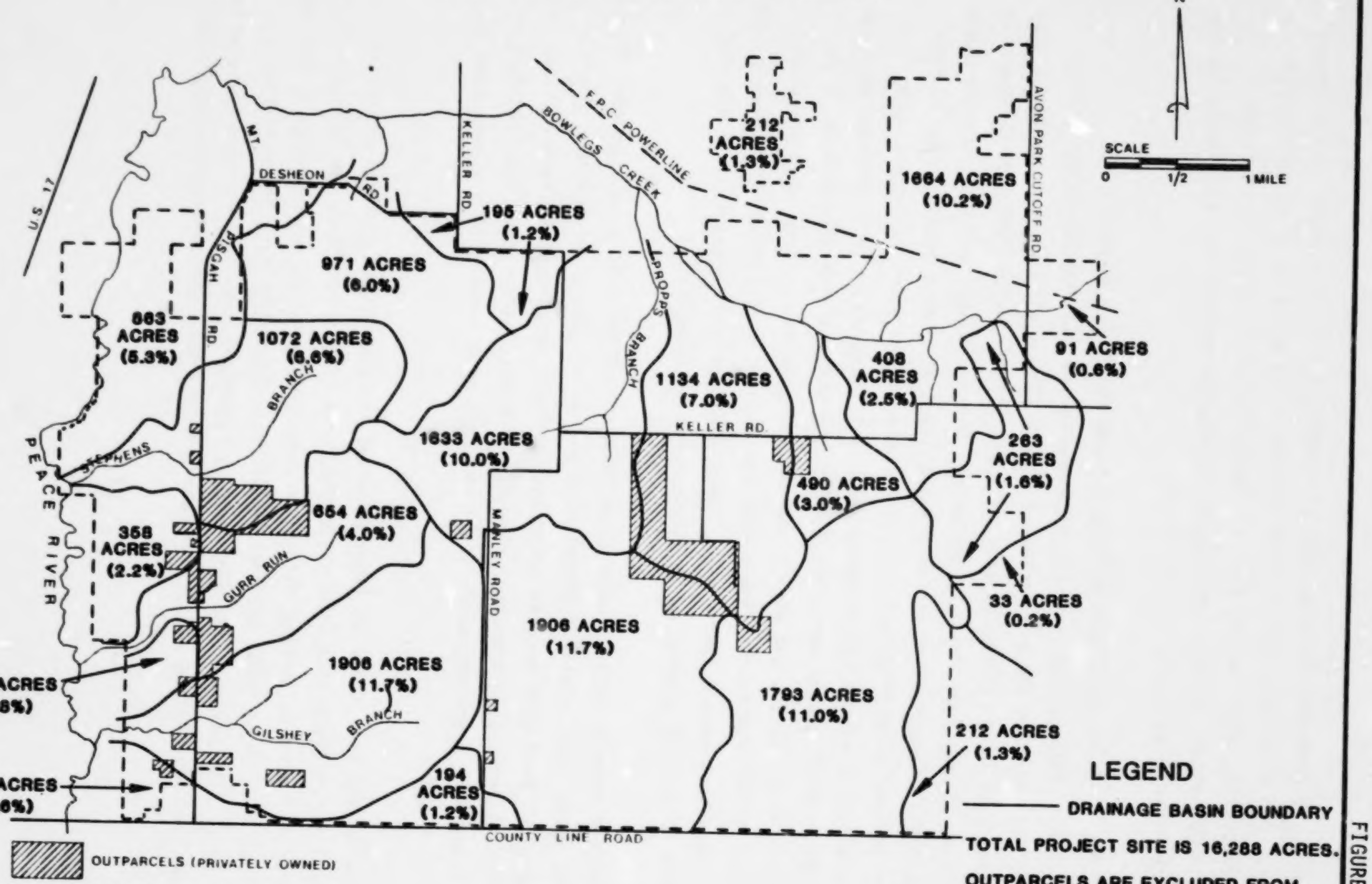
FIGURE 7-A



PEACE RIVER and TRIBUTARIES

SOURCE: AREAWIDE EIS (EPA, 1978)

DRAINAGE BASINS



TOTAL PROJECT SITE IS 16,288 ACRES.

OUTPARCELS ARE EXCLUDED FROM ACREAGE FIGURES.

SOURCE: STUDY DATA

comprise a combined drainage area of 5,089 acres or 31 percent of the project site. Two other sub-basins which include 4,138 acres or 25 percent of the project site, drain to the south. These sub-basins are part of larger drainage systems outside the project boundaries which eventually drain to the Peace River from Little Charlie Creek.

7.1.3 DATA COLLECTION METHODOLOGY AND QUALITY ASSURANCE

7.1.3.1 Methodology - Stream Flow Monitoring and Floodplain Delineation

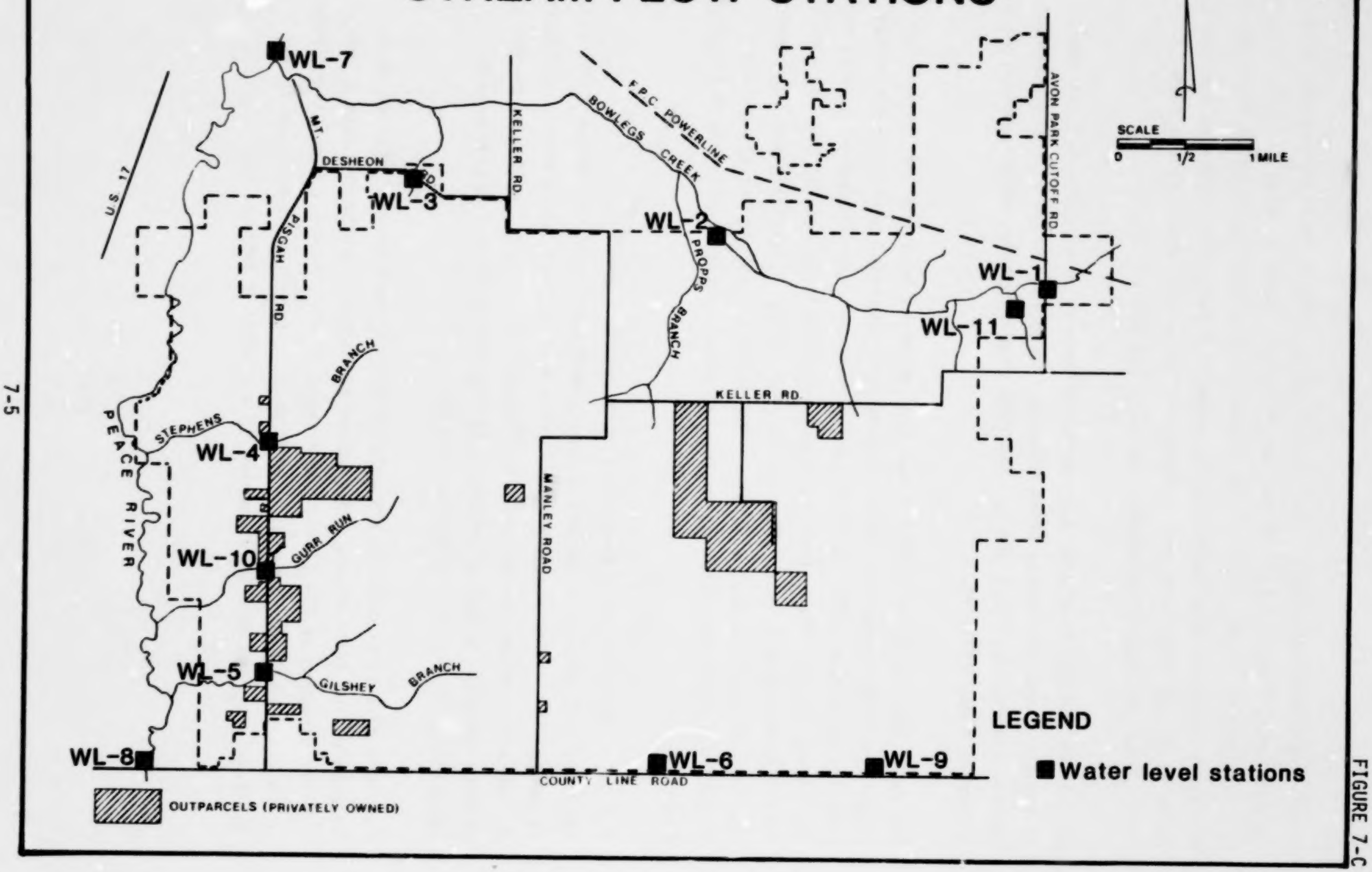
Data utilized for the evaluation of stream flow conditions were obtained from a ten-month data collection program (June 1979 to March 1980), from long-term data available from the U.S. Geological Survey (USGS), and from Florida State agencies. Gauging stations were established at eleven locations on or near the project site (Figure 7-C). Continuous stream level recorders were installed at six locations where perennial flows occur (WL-1 through WL-5 and WL-8). Staff gauges were installed on the streams with intermittent flows (WL-6, WL-9, WL-10, and WL-11) and at the upper Peace River station (WL-7). Since a USGS continuous flow measuring station is located at Fort Meade, continuous flow measurements at WL-7 were considered unnecessary. During the data collection program water levels were obtained weekly.

Stage-discharge curves (water level/flow relationships) were developed for all the water level stations except WL-6 and WL-9. These two stations' curves were not developed because intermittent flows, wide stream cross-sections and channel vegetation prevented flow measurements. After the stage-discharge curves were prepared, water level readings were converted to stream flow at each station.

Due to the wide range of flows observed at Peace River monitoring stations near the project site, the stage-discharge curves developed for Stations WL-7 and WL-8 were calibrated using the stage-discharge curve developed by the USGS near Fort Meade (USGS Station #02294898). Since the Fort Meade Station included only six years of continuously collected data, a long-term correlation was developed using additional data from the USGS Bartow Station (#02294650).

FIGURE 7-C

STREAM FLOW STATIONS



Flood elevations and profiles for the Peace River were developed by the USGS and Southwest Florida Water Management District (SWFWMD) using the USGS step-backwater model (USGS, 1978). Peak flood stage discharges used in the step-backwater analysis were determined by comparing long-term flow data for the Peace River and other regional streams. Flood elevation data developed in this manner are judged to be accurate to ± 0.5 feet.

Due to the limited flow data available for Bowlegs Creek (1964-68), it was necessary to use the Joshua Creek station (#02297100) stage-discharge curve to develop the Bowlegs Creek curve. The USGS step-backwater model was applied to determine flood profiles.

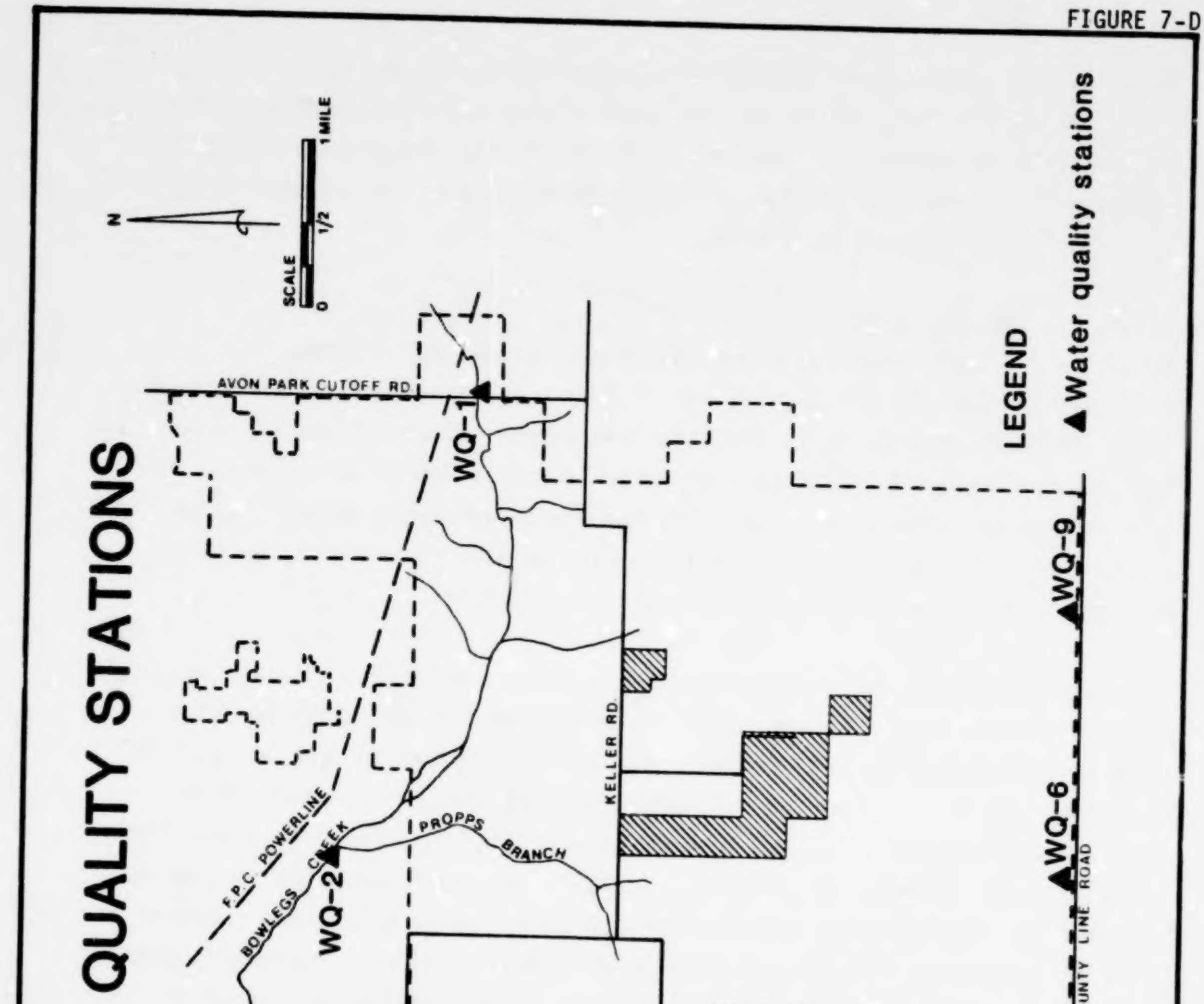
The small on-site tributaries' flows were measured on a limited basis. The stage-discharge curves for these streams were developed using the SCS runoff calculation method (SCS, 1973) in conjunction with the stage-discharge curve for Joshua Creek. The rainfall values used in calculating the 25- and 100-year floods were 8.5 inches for the 25-year, 24-hour rainfall, and 10.5 inches for the 100-year, 24-hour rainfall. The flood discharges for the selected tributaries were calculated at designated cross-sections utilizing Manning's Equation.

7.1.3.2 Methodology - Water Quality Sampling

Water quality data were collected over a nine-month period between April and December 1979. Nine stations, designated WQ-1 through WQ-9, were established for obtaining water quality samples (Figure 7-D). Their locations, on the streams passing through or discharging from the project site, generally coincided with the stream gauging stations.

Stations WQ-1 through WQ-6 were sampled one day each month. Station WQ-7, located on the Peace River, was sampled bimonthly close to the date of water quality sampling by the Florida Department of Environmental Regulation (FDER) at County Line Road, State Route 664 (WL-8). Due to extremely low flows, Stations WQ-8 and WQ-9 were sampled on a quarterly basis.

FIGURE 7-D


WATER QUALITY STATIONS
N
SCALE
0
1/2
1 MILE
LEGEND
▲ Water quality stations
OUTPARCELS (PRIVATELY OWNED)
AVON PARK CUTOFF RD.
WQ-1
F.P.C. POWERLINE
BOWLEGS CREEK
WQ-2
PROPPS BRANCH
KELLER RD.
KELLER RD.
MANLEY ROAD
COUNTY LINE ROAD
WQ-6
WQ-9
WQ-3
DESHEON RD.
MT. PISGAH RD.
WQ-7
BRANCH
STEPHENS
WQ-4
GURR RUN
WQ-8
GILSHEY BRANCH
WQ-5
PEACE RIVER
U.S. 17

Water quality samples were grab samples collected during daylight hours. Dissolved oxygen, temperature, pH and conductivity measurements were obtained in the field at the time of sampling. All additional chemical parameters were analyzed from preserved samples delivered immediately to the project laboratory facilities in Orlando, Florida.

7.1.3.3 Quality Assurance

Water samples were obtained in accordance with procedures outlined in "Standard Methods for the Examination of Water and Wastewater," 14th Edition, 1975. On each sampling date, the dissolved oxygen concentrations of select samples were analyzed by the Winkler-Azide Titration Method to calibrate and cross-check the reading obtained using the dissolved oxygen meter. The pH conductivity meters were periodically checked on each sampling day by calibrating against standard pH and conductivity solutions.

In conjunction with the monthly sampling, a blind sample was collected at one station on each sampling date. This was submitted for laboratory analyses without identification of the sample station. The results of the analyses on the blind sample were then compared with those of the known sample. Additional in-house quality control procecures were conducted by spiking portions of samples for comparative analyses. Analyses were also conducted on samples of known concentrations prepared by EPA. A second split sample was obtained from one station on three occasions and was submitted to the third-party consultant's laboratory to provide another check on the laboratory's accuracy.

The third-party consultant evaluated all quality assurance data. The blind sample results were accurate for most parameters, although there were occasional problems concerning the accuracy of the following parameters: coliforms, oil and grease, phenols, mercury, nickel and zinc. Spiked sample results were satisfactory with only a few having values outside the expected ranges. In general, agreement was observed in the samples split with the third-party consultant's laboratory. The only obvious discrepancies noticed were a single mercury analysis which had a significantly different detected value, and the TOC analyses which were typically lower at the third party consultant's laboratory. The results of the known EPA demand sample analyses were within the 95 percent statistical confidence limits of the known values.

Quality assurance audit summaries were prepared periodically by the third-party consultant and were submitted to EPA, Mobil Chemical Company, and the organizations concerned with performing the data acquisition tasks. As a result of the audit summaries, minor modifications to field and laboratory procedures were implemented during the program to assure the accuracy of the data collected. All quality assurance data and audit summaries are on file with EPA and Mobil.

7.1.4 SURFACE WATER CHARACTERISTICS

Baseline characteristics of surface water in the vicinity of the proposed South Fort Meade Mine are described within the following three subsections. The subsections address the three major surface water systems located on the site: the Peace River, Bowlegs Creek, and the small tributaries. Each subsection discusses water quantity and water quality separately.

Water quantity data include water level and flow measurements collected between June, 1979 and March, 1980 along with additional long-term data obtained from state and Federal publications. Flow data for each drainage system include average monthly flows, annual mean flows, 100-year flood flows and seven-day, ten-year low flows. Another factor examined is the relative discharge of Bowlegs Creek and the smaller tributaries to the Peace River.

Baseline surface water quality data include data collected from April, 1979 to December, 1979 and supplemental data from state and Federal sources. The data from the Peace River and Bowlegs Creek were statistically analyzed using a Water Quality Index (WQI) developed specifically for Florida streams by the FDER, Bureau of Water Analysis (FDER, 1979). The index was calculated using six of the nine water quality index parameters: dissolved oxygen, biochemical oxygen demand (BOD), suspended solids, nitrate, total phosphorus and total organic carbon. Zero or positive WQI values indicate generally good water quality while a negative WQI indicates inferior water quality. Mass loadings were determined for the Peace River, Bowlegs Creek, Gilshey Branch and Maron Run to evaluate the relative significance of the tributaries to their receiving stream.

The current State of Florida and Federal water quality criteria are presented in Table 7-1. Water quality limitations developed for the State of Florida are based on the intended uses of the water within specific segments. Chapter 17-3 of the Florida Administrative Code (FAC) contains the water criteria for the various water classifications. The revised FAC Chapter 17-3 (effective March 1, 1979) contains two sets of surface water quality standards which are applicable to waters affected by the proposed project: Section 17-3.061 General Criteria and Section 17-3.121, Class III Waters (used for recreation, and propagation/management of fish and wildlife). The U.S. EPA Quality Criteria for Water (EPA, 1976) was developed to offer protection to surface waters throughout the United States.

7.1.4.1 Peace River

7.1.4.1.1 Quantity

Peace River flow data collected at Stations WL-7 and WL-8, as well as USGS data recorded at the Fort Meade station, are presented in Table 7-2 and Table 7-3. Average monthly flows, annual mean flows, flood flows and seven-day, ten-year low flows recorded at the Peace River Fort Meade station are presented in Table 7-4. The data collection program conducted from June, 1979 to March, 1980 included monitoring a high-flow period occurring in September and October of 1979. These high flows resulted from two hurricanes which brought heavy rains to the central Florida area. The highest flow rates recorded during the six-year record for the station at Fort Meade occurred during this time frame and exceeded any previous daily maximum flow by 63 percent. Mean monthly flows recorded at the Fort Meade station during the 1979-80 study period were always higher than the estimated average monthly flows calculated for the station based upon historical data. The observed values varied from a low of 105 percent (July, 1980) to a high of 175 percent (September, 1980) when compared to the historic mean monthly flows.

As expected, the study period flows for Stations WL-7 and WL-8 were greater than the observed flows at Fort Meade. Flows at WL-7 were approximately one percent greater than the Fort Meade values. This difference is the result of a limited increase in drainage basin area at WL-7 and the additional runoff from non-point sources associated with this drainage area increment (Table 7-4). Flows at WL-8 averaged 136 percent of the flows for Station WL-7.

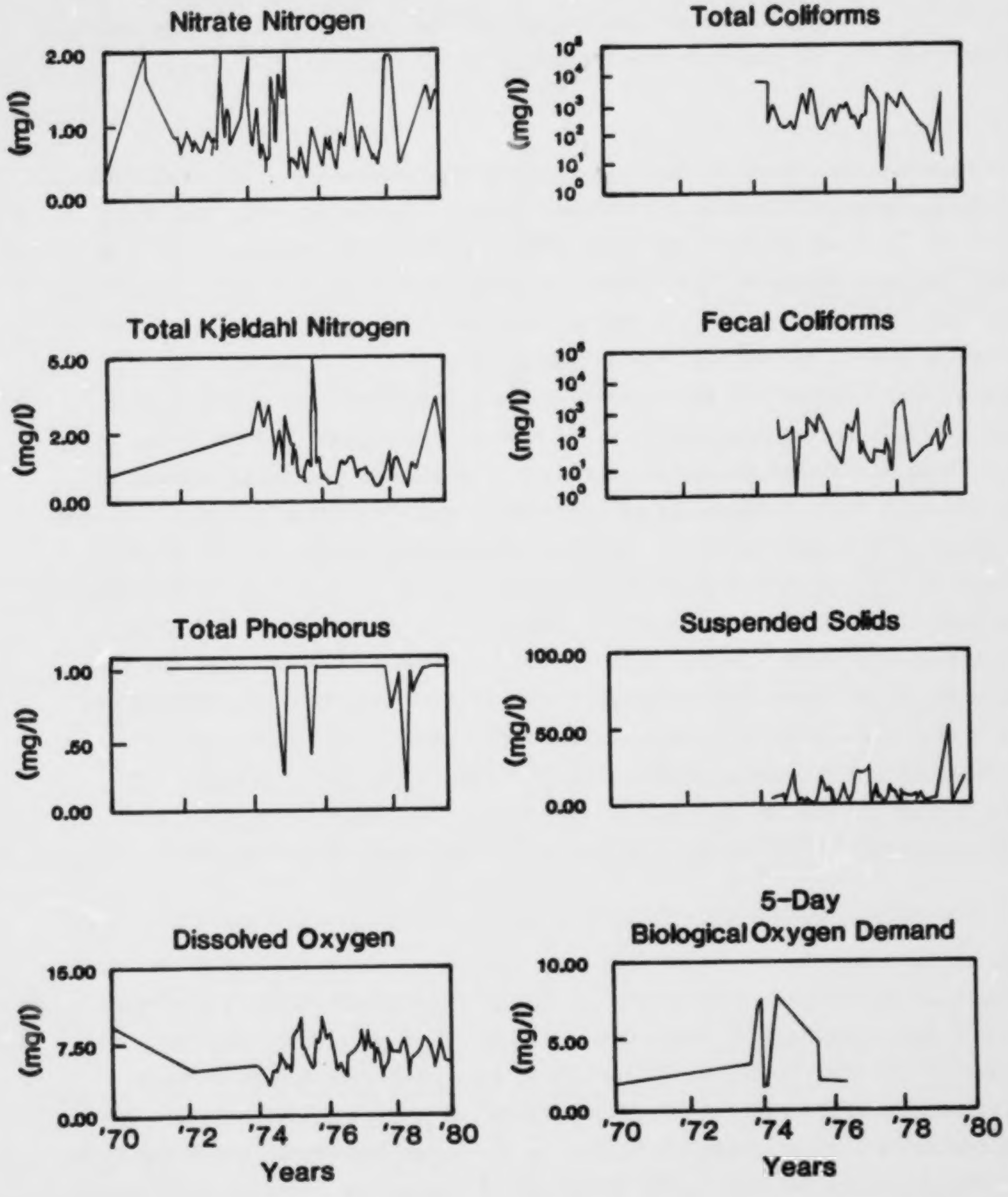
Flows at WL-8 exceeded those for WL-7 by 19 to 49 percent (June and December, 1980). This increased flow at WL-8 reflects additional non-point source flows as well as discharges from Whidden Creek, Bowlegs Creek, and the three small tributaries discharging from the project site.

7.1.4.1.2 Quality

The FDER has been studying Peace River water quality for several years, and sampling stations have been established from its headwaters near the Green Swamp to its mouth at Port Charlotte (FDER, 1980). FDER data indicate that total Kjeldahl nitrogen (TKN) levels vary from a high of 2.26 mg/l near Bartow to a low of 0.86 mg/l near its mouth. Average total phosphorus levels exhibit a similar trend, decreasing from a high of 3.08 mg/l to a low of 0.066 mg/l towards Port Charlotte. Mean nitrite-nitrate concentrations are low, with most stations having means below 0.93; however, at Highway 664 the value rises to 1.15 mg/l. The pH gradually increases from 6.78 in the upper reaches of the river to 7.89 at the mouth of the river. Mean low dissolved oxygen concentrations of 4.43 mg/l occur in the upper reaches of the river. Dissolved oxygen values increase downstream to a mean high of 7.51 mg/l at Zolfo Springs and drop to 6.4 mg/l at the mouth of the river, probably due to the tidal effects of Charlotte Harbor. Data indicate varying levels of fecal coliform bacteria in the Peace River between a mean high of 548/100 ml at Highway 664 and a mean low of 20/100 ml downstream (FDER, 1980). Data collected at Highway 664 are presented graphically in a time trend plot in Figure 7-E. Some degree of seasonal fluctuation can be seen in these plots; the most notable seasonal fluctuation is apparent in the dissolved oxygen plot.

Historic data indicate that some state water quality criteria are not always met in the Peace River basin. Dissolved oxygen concentrations below the state water quality criteria have occasionally been reported throughout the Peace River. Concentrations of heavy metals (cadmium, lead, mercury and zinc) in excess of the state water quality criteria have been detected at various locations along the river. The high nutrient and fecal coliform levels and low concentrations of dissolved oxygen in the upper portion of the Peace River are thought to be related to the discharge of sewage and industrial effluents in this area. Non-point source loadings may also contribute to poor water quality in the upper reaches of the river (FDER, 1980).

WATER QUALITY TIME TREND PLOT FOR PEACE RIVER
AT POLK-HARDEE COUNTY LINE FOR 1970-1980*



*DER APRIL, 1980

Historic data indicate fair to good water quality throughout the downstream reaches of the river. A comparison of historic and recent data indicates no temporal trends in water quality in the Peace River. Recent data indicate rising fecal coliform levels and decreasing pH and total phosphorus values during the period of record. In general, water quality in the Peace River appears poor near the headwaters of the river but improves substantially downstream (FDER, 1980).

Monthly data were collected by the FDER at Station WL-8; bimonthly data were collected at Station WQ-7. Water quality data collected during the sampling program are summarized in Table 7-5. The average monthly mass loadings for these stations are presented in Table 7-6. Data collected during the field survey reveal concentrations of total phosphorus, fluoride, iron, lead, mercury, and oil and grease exceeding either Federal or state criteria at some time. Dissolved oxygen concentrations dropped below criteria levels on several occasions. Fecal coliform values appear to be high; however, the variance occurring in laboratory duplicates samples prohibits a critical evaluation of these data.

Site-specific data show agreement with the results of the previously mentioned FDER study. The high nutrient levels, potentially high fecal coliform levels and low concentrations of dissolved oxygen are apparently related to the existing point source discharges in the upstream segments of the Peace River. Additionally, nonpoint source loadings from mined areas and citrus groves may also contribute to the poor water quality at Stations WQ-7 and WL-8.

The Peace River water quality data collected from Station WQ-7 were utilized for computing the State of Florida Water Quality Index (WQI). A value of -1.90 was computed from the data, indicating that the Peace River water quality near the project site is presently poorer than the average water quality state-wide.

7.1.4.2 Bowlegs Creek

7.1.4.2.1 Quantity

Bowlegs Creek average monthly flow data, collected at Stations Wl-1 and WL-2, are summarized in Table 7-7. The creek's flow rates correlate directly with the rainfall patterns of the area; high flows occur in late summer and early autumn, and low flows occur in the spring. The calculated average monthly long-term flows, annual mean flow, flood flows and seven-day, ten-year low flow for Bowlegs Creek are presented in Table 7-8. A seven-day, ten-year low flow of zero was assigned to Bowlegs Creek.

The contribution of Bowlegs Creek's flow (Stations WL-2 and WL-3 combined) to the Peace River (Stations WL-7, WL-3 and WL-2 combined) was evaluated by comparing their average monthly flows. On an annual basis, Bowlegs Creek's contribution was 26.1 percent; the mean monthly contribution never exceeded 40.5 percent of the Peace River flow (Table 7-9). The percentage contribution is slightly higher because Propps Branch flow and seepage from the banks of Bowlegs Creek between Station WL-2 and the mouth of the creek were not added into the calculations.

7.1.4.2.2 Quality

Two sets of water quality data were available for Bowlegs Creek. Water quality data from a previous EPA study (Jaunary 1970 to December 1976) were collected at a location slightly upstream of the project site (EPA, 1978). These data have been summarized in Table 7-10. Water quality data collected from Bowlegs Creek during Mobil's 1979 sampling program are summarized in Table 7-11. The data collected during the EPA study and the 1979 study appear to have similar concentration ranges for the parameters monitored.

The more recent data indicate the stream's dissolved oxygen levels have, on occasion, dropped below the state and Federal criteria. This can be attributed to nonpoint runoff from pastures, citrus groves, and areas remaining barren after previous mining operations. High total phosphorus, mercury, lead, cadmium, nickel and zinc levels also occurred during the sampling program. The high phosphorus levels may be naturally occurring or attributed to non-point source runoff from nearby mined areas or land under citrus cultivation. Reasons for the high trace metal concentrations are not apparent.

The water quality data for Bowlegs Creek were also evaluated with regard to the State of Florida Water Quality Index (WQI). The WQI computed for stations WQ-1 and WQ-2 were -1.03 and -1.00, respectively. These negative values indicate that the water quality of Bowlegs Creek is poorer than the average state wide.

Mass loadings (amount of pollutants) for Station WQ-2 (Table 7-12) were combined with those for Station WQ-3 in order to compare Bowlegs Creek and the Peace River. The loadings for Bowlegs Creek generally represent between <1.9 and 8.1 percent of the load at Station WQ-7 on the Peace River. The contribution of total organic carbon from Bowlegs Creek to the Peace River ranged from 1.3 to 4.1 percent. The comparative load of nitrogen species from Bowlegs Creek to the Peace River ranged from 0.3 to 8.1 percent. Phosphorus loadings were consistently 0.2 percent or less.

7.1.4.3 On-Site Tributaries

7.1.4.3.1 Quantity

The project site contains several small drainage systems resulting from groundwater seepage and/or surface runoff that flow into the Peace River and Bowlegs Creek. The southernmost sections of the site contain two intermittent drainage systems feeding tributaries which flow into Little Charlie Creek and eventually into the Peace River. The tributaries typically have their headwaters in wetland depressions and provide conveyance for excess water. Several of the stream channels have been altered by dredging and channelization to enhance drainage.

The on-site tributaries have highly variable flows, corresponding to runoff during seasonal rainfall and groundwater push due to variations in the surficial aquifer. The average monthly flows for those tributaries gauged during the 1979-80 monitoring program are presented in Table 7-13. Stations WL-6 and WL-9 were not gauged due to low water velocities and stream channel restrictions. The estimated average monthly flows (adjusted for long-term trends and flood flows) and seven-day, ten-year low flows for each of the key tributaries are presented in Table 7-14. The seven-day, ten-year low flow for each of the small on-site tributaries, including sections close to the mouth of each stream, was estimated to be zero. The reliability of this estimate was confirmed in conversations with the SCS, inspection of data collected on site, and comparison with the values developed for Bowlegs Creek.

The cumulative flow from the tributaries was compared to their respective receiving streams using the average monthly flows for each system. The yearly average flow of the three small Peace River tributaries on the project site (Stephens Branch, Gurr Run and Gilshey Branch) totalled 2.3 percent of the Peace River flow, with the average monthly flow of all three tributaries never exceeding 3.4 percent of the Peace River flow (Table 7-15). These values should actually be lower because additional flow exists from Propps Branch and Whidden Creek entering below the flow stations (WL-2, WL-3 and WL-7) but above the three on-site tributaries.

The flow contribution of the five Bowlegs Creek tributaries on the property (excluding Maron Run and Propps Branch) was determined by comparing the difference in average monthly flow measurements between stations WL-1 and WL-2 (Table 7-16). The average annual difference was 17.3 percent. This value does not take into account seepage from the banks of Bowlegs Creek which was estimated as the ratio of the distance along Bowlegs Creek from WL-1 to WL-2 to the combined lengths of the tributaries. With this adjustment, yearly average contribution of the tributaries was calculated to be 10.1 percent, with monthly values ranging from 6.7 to 12.6 percent. Maron Run's contribution to Bowlegs Creek was calculated by comparing Station WL-3 to the combined flow of WL-3 and WL-2 (Table 7-17). The average increase was 2.7 percent, with a range of 2.4 to 3.2 percent. This percentage is actually lower when the Propps Branch flow and seepage input are considered.

In summary, annual flow contributions from the tributaries to the receiving systems are small. The Peace River flow is increased by less than 2.3 percent due to the three on-site tributaries. Bowlegs Creek's flow is increased by approximately 13 percent due to the on-site tributaries.

7.1.4.3.2 Quality

Water quality data collected from the major on-site tributaries during the 1979 sampling program are summarized in Tables 7-18 through 7-23. The data appear to be highly variable for several key parameters including BOD_5, dissolved oxygen, total organic carbon, total nitrogen and total suspended solids. Variability in these parameters is common for streams such as these with extreme flow fluctuations.

Additional water quality data were collected from representative tributaries, Gilshey Branch and Maron Run, as indicated in Figure 7-F and 7-G. The additional data were acquired to characterize the changes in water quality from the mouth of these streams back to their headwaters (Tables 7-24 and 7-25). The upper reaches of the tributaries exhibit higher levels of nitrogen which can be attributed to surface runoff from pasture areas. The increase in fluoride concentrations in the lower stream sections may be attributed to increased groundwater seepage. Conductivity and color patterns also indicate a shift in influence from surface water or Surficial Aquifer to a deeper groundwater system.

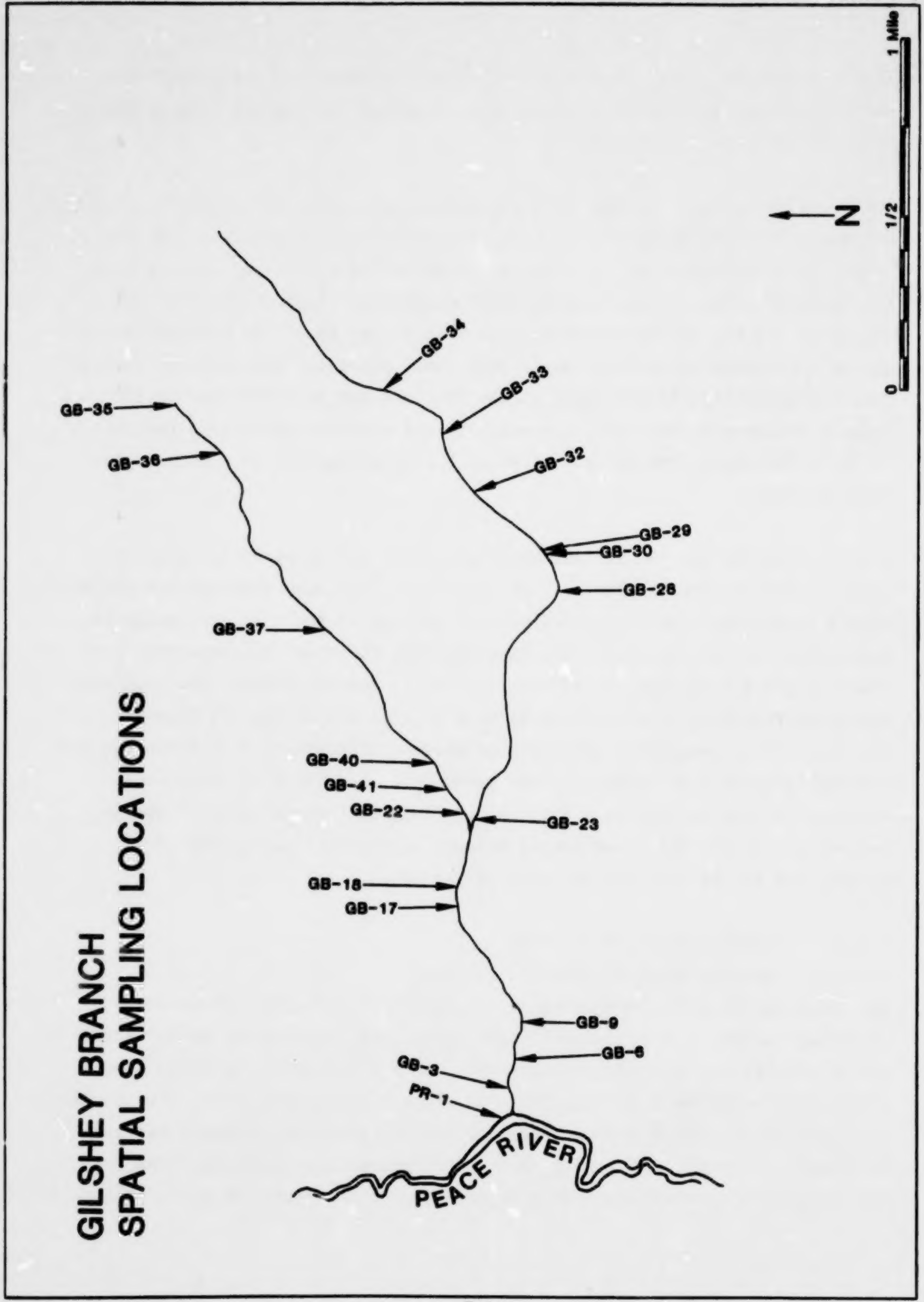
Mass loadings of the two streams were calculated and compared to those of their receiving streams (Tables 7-26 and 7-27). The mass loadings for Gilshey Branch consistently represent 0.1 percent or less of the load carried by the Peace River at Station WQ-7. The mass loadings for Maron Run represent less than 0.1 and 9.7 percent of the load carried by Bowlegs Creek. The load contribution from Maron Run tends to be more significant during the dryer seasons. Total phosphorus and orthophosphate contributions from Maron Run are somewhat greater than those of other parameters, ranging from 0.6 percent during high flow periods to 9.7 percent during low flow periods. Fluoride concentrations for Maron Run ranged between 0.7 percent during high flow periods and 9.1 percent during low flow periods.

7.1.5 SURFACE WATER UTILIZATION

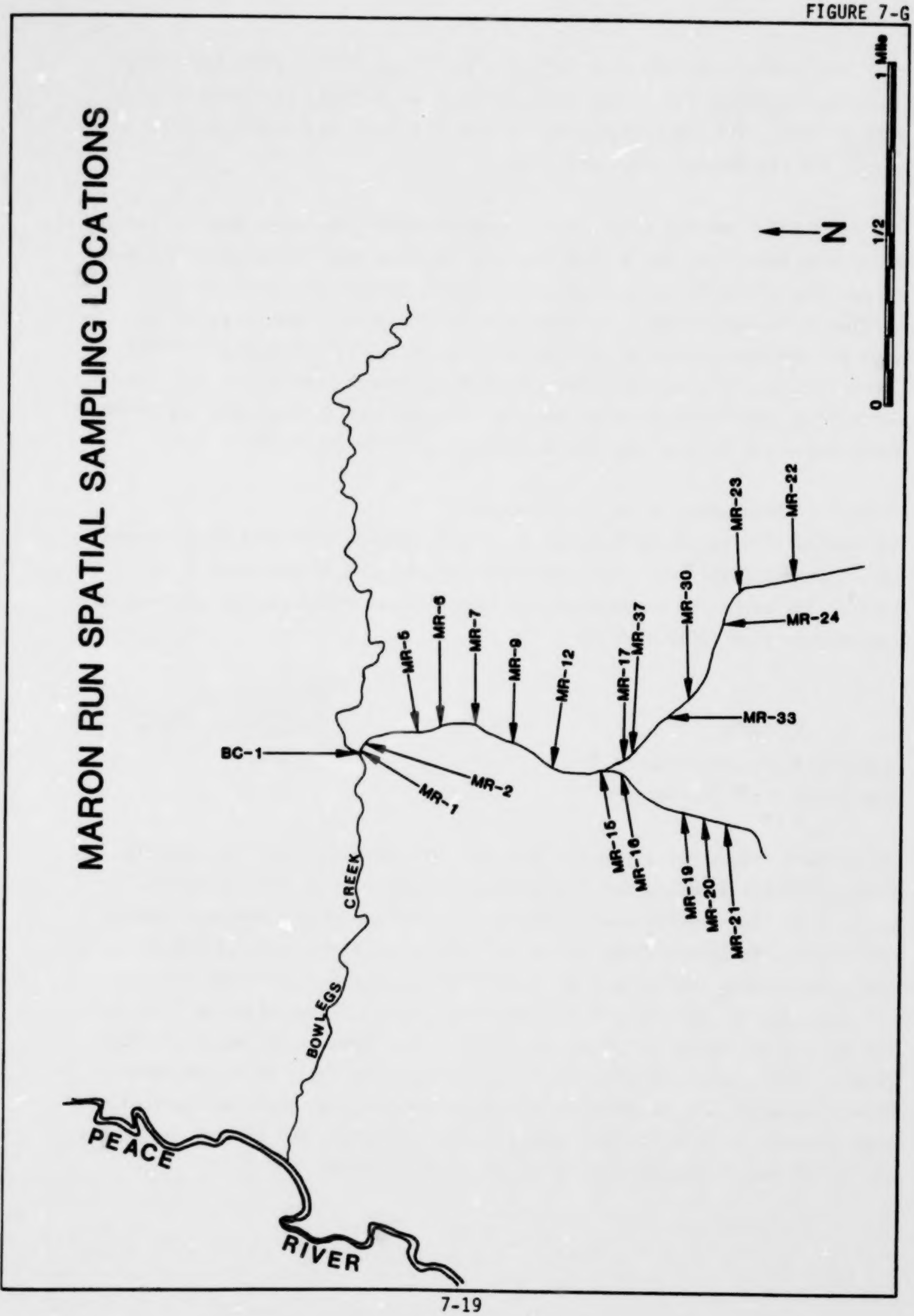
7.1.5.1 Surface Water Withdrawals and Uses

The Areawide EIS (EPA, 1978) reveals an absence of existing surface water withdrawal sites in the Polk County portion of the Peace River basin. There are no significant domestic or industrial water withdrawals, although some unpermitted withdrawals for agricultural and other uses may exist. Due to the poor quality of coastal area groundwater and the unsatisfied demand for surface water, planners are looking inland for future water supplies. The U.S. Army Corps of Engineers prepared a Water Resource Management Study in 1977

FIGURE 7-F



GILSHEY BRANCH
SPATIAL SAMPLING LOCATIONS



MARON RUN SPATIAL SAMPLING LOCATIONS

that identifies four potential surface water supply sites within the Peace River basin (Figure 7-A). The four sites are as follows: (1) Peace River-Whidden Creek, (2) Peace River-Charlie and Limestone Creeks, (3) Charlie Creek, and (4) Horse Creek, (EPA, 1978).

The Peace River-Whidden Creek site is located across the river west of the proposed mine site. The Peace River-Charlie and Limestone Creeks site lies downstream from the proposed mine site and extends through the south central portion of Hardee County. The Charlie Creek and Horse Creek sites are on separate drainage basins which flow into the Peace River downstream of the proposed mine site; neither creek drains the proposed mine site area. The Horse Creek and the Peace River-Charlie and Limestone Creeks sites are among those appearing to have the best interbasin transfer potential.

7.1.5.2 Discharges to the Surface Waters

The Central Florida Areawide Water Quality Management Plan (208 Study) identifies domestic and industrial wastewater dischargers to the Peace River basin. The following dischargers are identified as being located upstream of the project site (CFRPC, 1978):

Category	Number	Sum of Design Capacities (mgd)
Domestic Plant Dischargers	28	31.38
Industrial Plant Dischargers	38	927.61

The primary industrial discharges are from the phosphate industry; the 208 Study estimates a wastewater flow of 14.6 mgd per million tons of yearly production. Two power plants discharge over 300 mgd of once-through cooling water into Lake Parker which drains into the Peace River. The citrus industry discharges a much smaller but still significant amount of effluent that has the potential to contribute a very high BOD loading. The estimated flow rate for the citrus industry is 0.529 mgd per million boxes (1.75 bushel per box) (CFRPC, 1978). Most dischargers are operating below their permitted level. Other discharges and non-point source pollutants such as storm and agricultural runoff, small discharges exempt from regulations, and illegal discharges and spills may affect the quality of the surface water.

7.1.6 FLOODPLAINS

The flood profiles for the Peace River and Bowlegs Creek developed by the USGS and SWFWMD were used to determine the areal extent of the 25-year floodplains. The 25-year and 100-year floodplains coincide on Figure 7-H due to the scale of the map and the relative steepness of the slopes along the streams.

The 25-year floodplain was also delineated for four small tributaries within the project site: Propps Branch, which flows into Bowlegs Creek, and Stephens Branch, Gurr Run and Gilshey Branch which all flow into the Peace River (Figure 7-H). Flood flows (Table 7-28) and flood heights were determined for each cross section and compared to the land-elevation data to determine the areal extent of the 25-year floodplains depicted on Figure 7-H. The 25-year floodplains of the Peace River and its small tributaries encompass 639 acres, 4 percent of the project site. The 25-year floodplains of Bowlegs Creek and its tributaries encompass 574 acres, 3.5 percent of the project site.

Wetland areas are found within the project site along the Peace River, Bowlegs Creek and several of the tributaries, as well as in depressions occurring within the interior of the site. Many of these wetland areas are coincident with the floodplain areas; however, not all of the 25-year floodplain has been classified as wetlands. The total wetland acreage within the project site is 2,054 acres or 12.6 percent of the total project site. The biological resource document (Section 8.1.8 - Wetlands Classification) discusses these areas in greater detail.

7.2 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

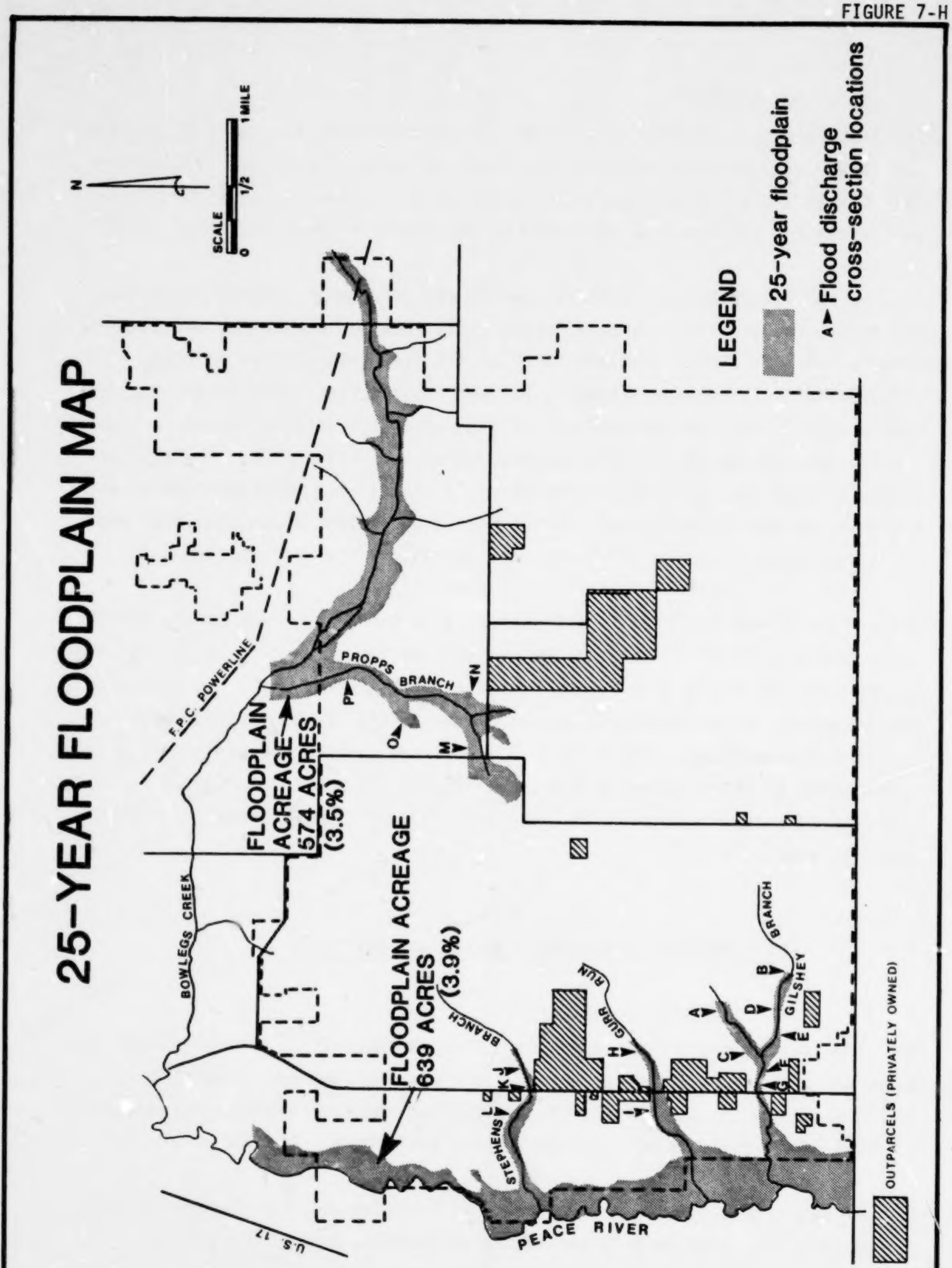
7.2.1 THE NO ACTION ALTERNATIVE

With the no action alternative no changes in the quantity of surface water are expected in the area of the proposed mine. Seasonal changes in water level and flow would continue without disruption, and the hydrologic characteristics of the streams and rate of baseflow to them would remain the same.

Surface water quality with the no action alternative would be determined by future land uses both on site and in the surrounding area. If land use

FIGURE 7-H

25-YEAR FLOODPLAIN MAP



patterns remain as today, surface water quality might remain much as it is. If other phosphate mines are constructed in the area, then surface water quality of select streams may show increases in parameters such as specific conductance, total dissolved solids, sulfate, and fluoride.

7.2.2 THE ACTION ALTERNATIVES INCLUDING THE PROPOSED ACTION

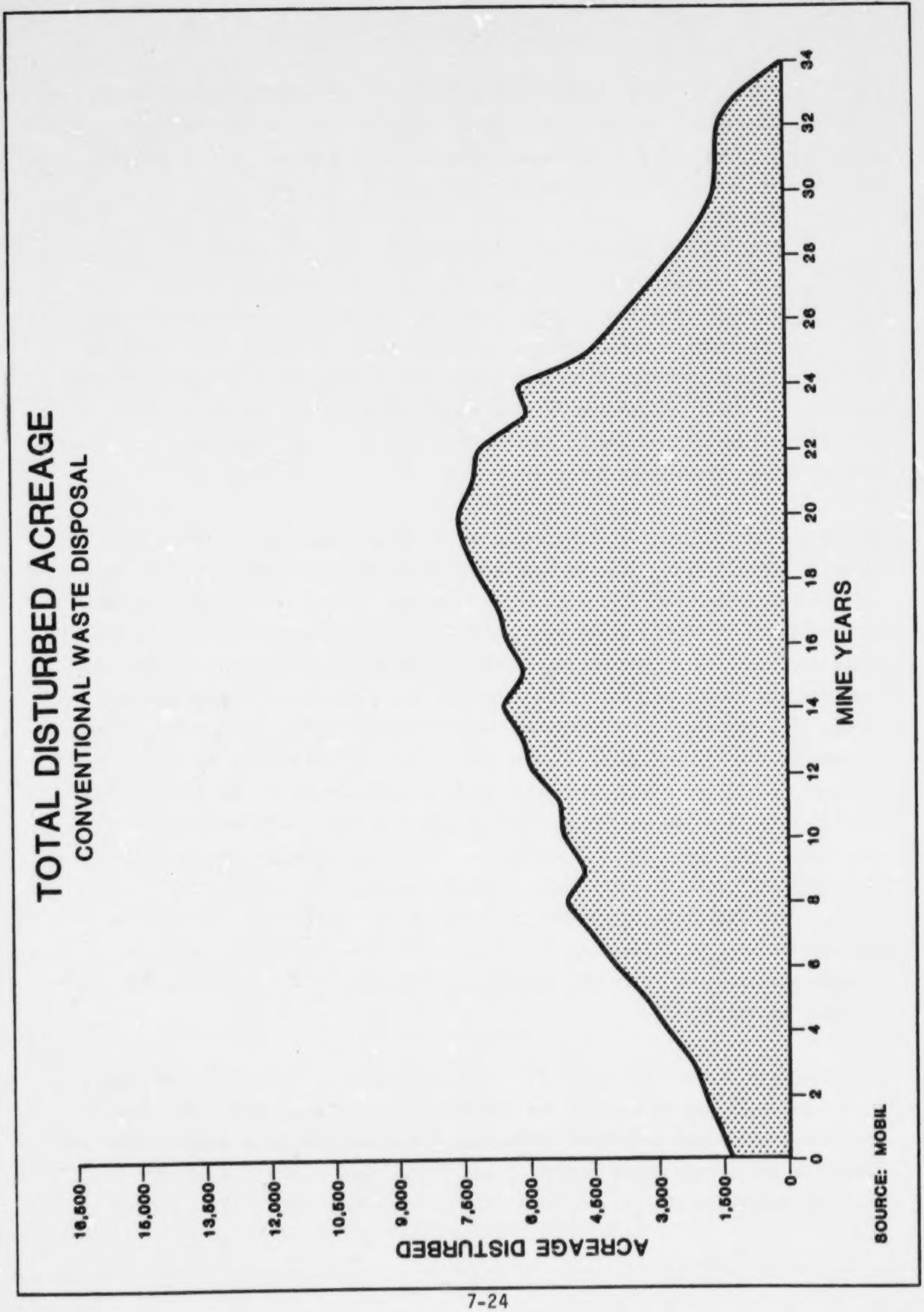
7.2.2.1 Mining Method Alternatives (See description DEIS 2.2)

Dragline (Mobil's Proposed Action): Dragline operations would require vegetation clearing on 50-acre tracts in front of each dragline. This would result in a small increase in surface water runoff flow and an increase in the sediment contained in the runoff as a result of erosion. The amount of cleared land should not exceed 100 acres at any one time, resulting in a minimal effect on surface water.

During the mining process, land would be mined and then later converted to waste disposal areas. This surface distruption would destroy the existing on-site tributaries of the Peace River and Bowlegs Creek. Precipitation occurring on these disturbed areas would be collected in the mine pits and disposal areas and directed to the recirculation system until reclamation is completed, reducing the amount of runoff from the site and thereby decreasing stream flows. The amount of disturbed land would vary during the mine life with the maximum area disturbed occurring in year 20 when approximately half the site would be in use for mining and waste disposal (Figure 7-I). During this time, the reduction in flow to the Peace River would be 8.5 cfs or 4.6 percent of the flow in the Peace River directly below the site (discounting any discharge flow from the plant water system). The maximum average flow reduction to Bowlegs Creek would be approximately 8 cfs or 17.4 percent of the flow in Bowlegs Creek as it leaves the property. These flow reductions would be temporary with flows returning to normal at the completion of mining and reclamation activities.

The reduction in surface runoff and flow in on-site tributaries would result in a minor decrease in organic and nutrient mass loadings (BOD, TOC, total phosphorus and total nitrogen) to Bowlegs Creek and the Peace River. The flow reduction would reduce the organic load to the Peace River by 2 percent or less and total phosphorus and total nitrogen by 1 percent or less. These

FIGURE 7-I



TOTAL DISTURBED ACREAGE
CONVENTIONAL WASTE DISPOSAL

SOURCE: MOBIL

changes in surface water quality would be temporary, and the stream quality is expected to eventually return to normal after mining and reclamation activity ceases.

Bucket Wheel: The bucket wheel method of mining would have impacts on the site and the adjacent waterways essentially identical to those of the proposed action.

Dredge: The dredge mining method would also disrupt large areas of land during the mine life. The effects of this disruption on surface water quantity in the area would be similar to those described for the proposed action.

The dredge mining method would require large diked and flooded areas. During the mining operation, the water level in the dredge pool would maintain the water table level in the surrounding Surficial Aquifer and, therefore, maintain groundwater baseflow contribution to any stream in the immediate area of mining. The dredging operation would increase the concentration of total suspended solids, organic material, and inorganic material in the dredge pool water. Adverse water quality impacts could occur if turbid water from the dredge pond were released to surface waters.

7.2.2.2 Matrix Transfer Alternatives (See description DEIS 2.3)

Pipeline (Mobil's Proposed Action): Mining on the north side of Bowlegs Creek would require a matrix slurry pipeline stream crossing of Bowlegs Creek during a four year period of the mine life. If a break or leak occurred in the transfer line at the stream crossing, suspended solids, nutrients and sediment, would be dramatically increased and smaller increases in Ra-226, specific conductance, and total dissolved solids would occur in Bowlegs Creek. The effects on water quality would be for a short time until corrective clean-up action were taken. The use of valves and double-walled pipe as described in Mobil's proposed action would minimize the potential for a spill occurrence at the stream crossing.

Conveyor Belt: The potential for spillage of matrix material at a stream crossing is also a possibility with the conveyor belt system. However, since the material would be in a solid rather than slurried condition, the resulting effects of a spill would be expected to be less than for the proposed action.

Truck: A spill resulting from matrix transfer by truck is possible but least probable of the three alternatives. Should a spill occur it would amount to a small volume of material in solid form. The resulting effects of a spill should be minimal.

7.2.2.3 Matrix Processing Alternatives (See description DEIS 2.4)

Conventional Beneficiation (Mobil's Proposed Action): Several reagents would be utilized during the feed preparation and flotation processes: sodium hydroxide, fatty acid, fuel oil, sulfuric acid, amines and kerosene. The majority of the reagents would react during the beneficiation process to form sulfate compounds and would be discharged from the process in the waste sand tailings and clays. The reagents used and the dilution ratio in the wastewater if the reagents passed through the flotation process without chemically reacting would be as follows:

	Dosage, gal/day	Dilution
No. 5 Fuel Oil	4,230	13,200:1
Fatty Acid	2,680	20,900:1
Sulfuric Acid	3,040	18,400:1
Amine	530	105,700:1
Kerosene	450	124,400:1
Caustic	190	294,700:1

Water from the sand tailings disposal areas would be introduced into the recirculation system where the reagent compounds would again be mixed with the waste clays. The natural affinity of the reagents for phosphatic clay would result in their adherence to the clay particles, leaving only trace amounts of reagents in solution. The discharge from the clear water pool would contain low concentrations of the reagents and reagent-sulfate compounds.

Waste sand and clay would be pumped from the beneficiation plant in slurry form to waste settling areas. Should a leak develop in a transfer line, flooding and potential surface water contamination could result. The only stream crossing would be a sand tailings line crossing Bowlegs Creek occurring in years 21 and 22 of the mine life. The crossing would be located in the same area as the dragline crossing. Should a break occur at the crossing, flow and sedimentation would increase in Bowlegs Creek for a short time until corrective clean-up action were taken. There are no clay slurry lines crossing surface water streams on the site, and the shortest distance between a clay slurry line and any surface water stream (Bowlegs Creek or the Peace River) would be approximately 3,000 feet.

Dry Separation: Processing the matrix by dry separation would not require reagents, large quantities of water, or diked basins for water clarification. Dry separation would have minimal potential for affecting surface water quantity or quality.

7.2.2.4 Waste Disposal Alternatives (See description DEIS 2.5)

Conventional Clay Settling Case (Mobil's Proposed Action): A primary concern with above-ground settling basins is the potential for dike failure. In the event of a failure, large volumes of clay could be discharged into Bowlegs Creek and/or the Peace River increasing turbidity, destroying natural biological communities, depositing sediments, and raising the concentrations of sulfates, fluorides, and total dissolved solids.

During the life of the mine, approximately 8,170 acres of above-grade clay settling basins would be constructed with dike heights ranging from 25 to 45 feet and averaging 38.7 feet. The highest probability for a dike failure would be when the greatest amount of active above-grade settling acreage was in service. For the conventional clay settling case this would occur in mine years 12 through 14 when five basins (CS-4, CS-5, CS-6, CS-7 and CS-8) covering 2,790 acres are all active, operating in a flow through settling mode. If a dike failure occurred during this time, it is estimated that the impounded clays that would be released would range from 12,000 acre-feet (if the break occurred on CS-5) to 22,500 acre-feet (if the break occurred on CS-6). Because of the natural topography of the site, most of the clays released would probably flow into Bowlegs Creek or the Peace River. It is doubtful that any off-site property would be affected except for the roadways that pass through the site. The primary effect would be to the on-site and downstream sections of the Peace River and Bowlegs Creek. Spills could also occur from other isolated clay settling areas. The primary effect would still be degradation of water quality in the Peace River or Bowlegs Creek.

The technology used to construct the settling basin dikes has improved substantially during the past decade, reducing the likelihood of a dike failure. Thorough investigations of foundation and soil conditions at the location of the proposed dikes would be conducted on the South Fort Meade site prior to design and construction. The dikes would be continuously inspected and monitored during the active life of the settling basins. Mobil would comply with the regulations for design, construction and maintenance of earthen dams established by the Florida Department of Environmental Regulation (FAC Chapter 17-9).

Sand/Clay Cap Case: The sand/clay cap waste disposal case has dike configurations similar to that of the conventional clay settling case; however, the average dike height is decreased two feet. Flow through settling would not be practiced with this waste disposal case; therefore, the amount of above-grade settling acreage active at any one time would be reduced. Basin CS-3 would be used during the life of the mine as a dredge basin and would be filled and emptied several times during the mining activities. The greatest amount of active above-grade settling occurs in mine years 17 through 19 when CS-3 and CS-10, with a maximum area of 1,860 acres, are active. The potential for a dike failure occurring is decreased for the sand/clay cap waste disposal case compared to the proposed action because of the reduced active settling acreage (less than 1,860 acres compared to 2,760 acres). If a dike failure occurred during this time it is estimated that the impounded clays that would be released would range from 25,500 acre-feet (if the break occurred on CS-10) to 33,600 acre-feet (if the break occurred on CS-3).

The effect of a dam failure would be the same as that described for the proposed action except that total quantity of clay that could potentially spill would be reduced by 21 percent for the sand/clay waste disposal case compared to the conventional clay settling case. This reduction results from the lower average clay fill height with the sand/clay cap case (27 feet versus 34 feet).

Sand/Clay Mix Case: The sand/clay mix waste disposal case has 4,827 acres of above-grade clay settling basins with dike heights from 40 to 48 feet, and 3,352 acres of above-grade sand/clay mix basins with dike heights from 20 to

37 feet. The 4,827 acres of above-grade clay settling basins would be operated in a manner comparable to the sand/clay cap case and could not utilize flow through settling since these areas will be dewatered quickly in order to cap them with sand/clay mix. Two dredge basins would be constructed to provide clay for sand/clay cap material as well as sand/clay mix for the 3,352 acres of mix basins. The greatest amount of active above-grade settling acreage would be in mine years 10 through 11 when CS-1, CS-2, CS-3, CS-4 and CS-5, with a maximum area of 2,450 acres, are active. Therefore, the potential for a dike failure occurring is greater than the sand/clay cap case but less than the conventional clay settling case.

The sand/clay mix case has two types of above-grade basins: sand/clay mix and conventional clay settling. The sand/clay mix material would consolidate more rapidly and would have a higher density than the clay wastes impounded separately. This increase in density and consolidation would result in a decrease in flow characteristics of the mix material should a dike failure occur from one of the mix basins. Therefore, the effect of a sand/clay mix spill would be less than that expected from a clay settling basin spill because the spill would not cover as large an area. If a dike failure occurred from one of the clay settling basins the effect would depend on the quantity of material released but would be similar to that described under the conventional clay settling case.

Overburden Mix Case: The configuration, size and active settling acreage of above-grade basins with the overburden mix waste disposal case are similar to the sand/clay mix case; however, the extent of sand/clay mix impoundments would be increased to 5,492 acres. The average dam height would be 38 feet. The potential for a dike failure and resultant effect on surface water streams would be comparable to those described for the sand/clay mix basins under the sand/clay mix case.

7.2.2.5 Reclamation Alternatives (See description DEIS 2.6)

Conventional Clay Settling Plan (Mobil's Proposed Action): The Peace River and Bowlegs Creek would not be directly disturbed by the mining operation but would be influenced by alterations to the site's drainage patterns. The onsite tributaries and drainage areas disturbed by mining would be reconstructed as close to the premining conditions as the reclaimed topography would allow. A comparison of existing and post reclamation drainage areas within the major drainage systems found on the South Fort Meade site is summarized in Table 7-29.

The Peace River would receive five percent less direct surface drainage from the site. Bowlegs Creek's drainage area from the site would be reduced by six percent after reclamation. The Parker Branch drainage basin in the southern part of the site would be enlarged by approximately 17 percent. These variations are not substantial alterations to the overall drainage patterns of the site and since all the surface water eventually flows into the Peace River, the total Peace River drainage basin and river flow would not be changed.

Approximately 60,000 linear feet of stream channels disturbed by mining would be restored during reclamation. Reclaimed stream channels would be developed in tailings fill with overburden cap or in overburden fill areas. These soil compositions are the most suitable for establishing stable channels because they are less susceptible to erosion and subsidence and can be successfully reforested with native wetland species. The proposed plans provide for the creation of a water level and an associated floodplain, similar to premining conditions, which would allow effective conveyance of flood flows. Shallow pools would be constructed at intervals of approximately 500 feet along the length of the new channels. Above-grade reclaimed waste disposal areas would drain to small marsh areas between 5 and 40 acres in size. These small marshes would be connected by overflow swales to a reconstructed stream channel.

Some minor alterations of surface runoff quantities and peak flows would be observed after reclamation. The increased clay content of the reclaimed soils in the 8,170 acres of clay settling areas would increase and, therefore, increase the total runoff quantities and peak flows expected following a rainfall. The marsh areas at the discharge location of the basins and shallow pools in the stream channels would provide some storage capacity and water rention which would minimize the increases in peak flows. The runoff quantities and peak flows from the sand tailings fill areas (5,034 acres) would be similar to the premining conditions.

After reclamation, stream water quality would be influenced primarily by pollutants carried in the runoff. The site would be reclaimed for agricultural and silvicultural uses. Small marsh areas established in the above-grade reclaimed areas and two large wetland areas (totaling 1,513 acres) would accumulate surface runoff from surrounding upland areas, trap sediment and filter excess nutrients. As the reclaimed streams mature, the channels will form natural meanders, and benthic communities will become re-established. The water quality found within the established reclaimed streams would be similar to that presently found in the streams.

Sand/Clay Cap Plan: The surface water impacts resulting from the sand/clay cap reclamation plan would not vary greatly from the impacts discussed for the proposed action. Slight differences in the major drainage areas, as identified in Table 7-30, are associated with this case.

The total acreage of the above-grade clay settling areas would be the same as with the conventional plan; however, 93 percent of these areas would be capped with five feet of a 4:1 mixture of sand and clay and the remaining above-grade clay settling areas would be capped with one foot of overburden. Runoff quantities from these areas should not differ greatly from the premining conditions due to the similar permeability and infiltration and, therefore, similar runoff characteristics.

The total reclaimed and undisturbed wetland areas would be 2,057 acres which is seven percent greater than provided with the proposed action. Stream channel reclamation would be similar to that described for the proposed action except for the reclaimed channel of Propps Branch where excavation and rough grading would be done during final restoration when the surface sand/clay mix (4:1) had consolidated to 30 percent solids. Further subsidence of this basin and stream channel could create additional wetland areas along reclaimed Propps Branch. Water quality should not differ substantially from the conventional case due to the similar post reclamation land use anticipated. However, less fertilizer would be required for agricultural uses with the sand/clay cap plan than with the conventional case.

Sand/Clay Mix Plan: The sand/clay mix reclamation plan has surface water impacts different from that of the proposed action resulting from differences in the reclaimed drainage basin areas, wetland areas and the restoration of Propps Branch. The major drainage basin areas under this case are identified in Table 7-31.

The sand/clay mix reclamation plan would provide 2,255 acres of wetlands, 343 acres more than the conventional reclamation plan. This would provide greater water storage, filtering of nutrients, and removal of sediment.

The reclaimed stream channels would have a slightly different configuration than with the proposed conventional reclamation plan. Reclaimed portions of Propps Branch would be developed in a sand/clay mix (2:1) settling area. Stream restoration could be difficult within this area due to the susceptibility of the sand/clay mix to soil erosion. Other stream restoration would be performed in overburden material with a high content of sand which does not erode as easily as clay or 2:1 sand/clay mix. The unstable conditions in this drainage basin could slightly increase the suspended solids loading to Bowlegs Creek.

The sand/clay mix plan calls for 3,737 acres of clay surface, 3,020 acres of overburden cap surface, and 7,237 acres of 2:1 sand/clay mixture surface. The primary land uses anticipated for these areas are agriculture and silviculture, both of which are currently practiced. Constituent runoff loadings, flow and other water quality parameters are not expected to be substantially different from those anticipated for the proposed action.

Overburden Mix Plan: This reclamation plan would have similar drainage areas and employ similar restoration techniques to those discussed for the sand/clay mix plan. The primary change for this plan would be a greater surface area with 2:1 sand/clay mixture surface. The overburden mix plan has 8,339 acres of sand/clay mix surface while the sand/clay mix plan has 6,697 acres. This should increase the surface permeability and reduce runoff flow quantities from these areas. Wetland areas and stream restoration would be similar to that of the sand/clay mix plan.

7.2.2.6 Water Source Alternatives (See description DEIS 2.7)

Groundwater (Mobil's Proposed Action): The major quantity of process makeup water would be obtained from the Lower Floridan Aquifer. The impacts to surface water systems would therefore be minimal.

Surface Water: The use of surface water as the primary source of process water could be accomplished by impounding Bowlegs Creek. If Bowlegs Creek were impounded, the effect would be a severe flow reduction downstream of the impoundment as well as a disturbance of the natural floodplains and wetlands directly above and below the impoundment. Downstream flow reductions would reduce the Peace River's flow by approximately 26 percent and would deprive the river of natural nutrient and organic loads it presently receives from Bowlegs Creek. A problem associated with using surface water as the primary supply for processing is the need for additional water treatment.

7.2.2.7 Water Discharge Alternatives (See description DEIS 2.9)

Peace River (Mobil's Proposed Action): The primary discharge from the mining area would occur from the 45-acre clear water pool adjacent to the processing facility. Under the proposed plant siting, the clear water discharge would flow into the Peace River by way of a vegetated drainage swale (outfall ditch) constructed along the railroad spur route. The mine would have an intermittent discharge from the clear water pool primarily between the months of May through October, the months with increased rainfall. The discharged volume would be directly dependent on the local rainfall. The months when discharge is expected to be the greatest are June through September, a period when tropical storms are frequent in Florida.

The main areas of concern for water quality include pH, total suspended solids (TSS), total phosphorus and fluoride. The NPDES discharge data for Mobil's existing Fort Meade Mine indicate no significant fluctuations in pH (values range between 6.8 and 8.1 for the year). The discharge at the proposed mine would have a similar pH range and should not degrade the water quality of the receiving stream. Characteristic mass loadings (Table 7-32) were developed for the proposed South Fort Meade Mine discharge based on the constituent concentrations for the existing Fort Meade Mine discharge as well as other phosphate mines in the area. The mass loadings were developed for a wet season discharge of 9 mgd and a maximum discharge of 20 mgd, representing the 25-year storm event.

An evaluation of the present surface water characteristics and the projected characteristics during mining operations indicates that when the mine effluent is mixed with the Peace River's average flow between June and September, the concentrations of TSS, total phosphorus and fluoride would be 30 mg/l, 2 mg/l and 1.2 mg/l, respectively (Table 7-32). These values are very similar to those naturally occurring from the mass loadings of the existing tributaries. The calculations are based on average river flow during a year with normal rainfall patterns. Average flow conditions are used instead of low flow conditions because discharge from the water system results from high rainfall events or periods when high river flows would be expected. The loading can be much greater or much less, depending on the rainfall trends. Discharge flows are based on normal flows derived during the mine year when the largest area will be included within the recirculation system. Before and after this peak year, less of the mine site will influence the waste discharge and more acreage within the site will contribute direct runoff to the streams.

There would be additional outfalls associated with the spillways of individual settling basins, but these would only discharge to Bowlegs Creek and Stephens Branch in extreme circumstances when excessive rainfall is anticipated to overtop the basins. Over the active mining period, the location of the emergency discharge outfalls would shift as basins are reclaimed. The quantities of constituents that might be released from an emergency spillway while lowering the water levels in the basins to create capacity for a threatened excessive rainfall (a hurricane, for example) would depend on the total area of basins in use, and that area will change over the life of the mine operation. Table 7-33 presents the worst case existing concentration of water quality parameters of concern for the Peace River, Bowlegs Creek, Stephens Branch and the expected concentration of these same parameters in clay settling pond supernatant waters. The only Florida water quality standard that might be violated by discharge of clay settling pond supernatant was specific conductance. If this stream were discharged to Bowlegs Creek, the average discharge rate would have to be less than about 53 cfs (105 acre-feet/day) to avoid exceeding the allowable 100 percent increase in specific conductance. (This assumes a flow of 60 cfs in Bowlegs Creek, a typical flow during the summer when excessive rain would be expected.) Discharge into Bowlegs Creek would increase the concentrations of specific conductance, total dissolved solids, bicarbonate, sulfate, chloride, and fluoride. Discharge into Stephens Branch would increase the concentration of specific conductance, total dissolved solids, bicarbonate, sulfate, and fluoride.

If the clay pond supernatant were discharged to the Peace River during the summer when the river flow typically might be 150 cfs, a discharge of about 1,230 cfs (2,430 acre-feet/day) would not raise the specific conductance of the river to the maximum of 500 umhos/cm. Discharge into the Peace River would increase the concentrations of specific conductance, total dissolved solids, bicarbonate, sulfate, silica, and fluoride.

Bowlegs Creek: The discharge characteristics would be the same if the primary water discharge is directed to Bowlegs Creek instead of the Peace River. Because the flow in Bowlegs Creek is substantially less than that of the Peace River, the impact of the waste load would be greater. The mine discharge would increase the creek's average flow immediately downstream of the site from 24.6 mgd (38 cfs) to 33.6 mgd (52 cfs). This increase in flow could cause additional scouring of the stream channel and a corresponding increase in turbidity. The additional flow would also increase the area affected by flooding during storms.

An evaluation of the effects of discharging to Bowlegs Creek indicates that concentrations of the three water quality parameters of concern would increase slightly with the introduction of the mine effluent. The TSS concentrations after mixing would increase from 10 mg/l to 14 mg/l, the total phosphorus concentration would increase from 0.24 mg/l to 0.98 mg/l, and the fluoride concentration would increase from 0.14 mg/l to 0.64 mg/l.

The effluent discharged to Bowlegs Creek would eventually flow into the Peace River. The impact on the river will be even less discernible than that previously discussed due to the additional dilution and mixing of the effluent prior to its entry into the river.

7.2.2.8 Product Transport Alternatives (See description DEIS 2.10)

Railroad (Mobil's Proposed Action): A concern associated with rail transport is the potential of a spill occurring at the Peace River crossing. If such an event should occur, phosphate rock would enter the stream, increasing suspended solids and sediment material and temporarily degrading the water quality of the river.

Truck: Truck transport of the phosphate rock would affect surface water in the same way as rail transport in the event of a spill. The size of a potential spill with a truck would be less than with rail transport.

7.3 REFERENCES

Central Florida Regional Planning Council., 1978. Central Florida Areawide Water Quality Management Plan, Bartow, Florida.

Florida Department of Environmental Regulation, 1979. Development of a Water Quality Index, prepared by Water Quality Monitoring Section, Bureau of Water Analysis.

Florida Department of Environmental Regulation, 1980. Water Quality Inventory for the State of Florida, prepared by Division of Environmental Programs, Bureau of Water Analysis.

Soil Conservation Service - U.S. Department of Agriculture, 1973. A Method for Estimating Volume and Rate Runoff in Small Watersheds, Technical Paper 149.

Southwest Florida Water Management District, 1979. Floodplain Information on Bowlegs Creek from Peace River to S. Buffman Road, Polk Co.

State of Florida, 1979. Florida Administrative Code (FAC) 17-3, Florida Department of Environmental Regulation.

U.S. Geological Survey, 1978. Flood Profiles for Peace River, South-Central Florida Water-Resources Investigation 78-57, Southwest Florida Water Management District.

U.S. Environmental Protection Agency, 1978. Central Florida Phosphate Industry Areawide Impact Assessment Program, Volume V: Water, prepared by Texas Instruments, Inc.

U.S. Environmental Protection Agency, 1976. Quality Criteria for Water, Washington, D.C.

TABLE 7-1

STATE OF FLORIDA AND FEDERAL WATER QUALITY CRITERIA

Parameter	F.A.C. 17-3 General Criteria	F.A.C. 17-3 Class III	EPA Water Quality Criteria
Alkalinity, Total as $CaCO_3$ (min.)	--	20	20
Alkalinity, Phenolpathalein	--	20	20
Aluminum	--	1.5	--
Ammonia (non-ionized)	--	0.02	0.02
Antimony	--	0.2	--
Arsenic	0.05	--	--
Bacteriological (Coliform, Total and Fecal)	--	1000/100ml. Tot. 200/100ml. Fec.	200/100ml. fecal
Barium	--	--	1.0
Beryllium	--	0.011	0.011 (Softwater) 1.100 (Hardwater)
BOD (5-day)	Note 1	--	--
Boron	--	--	0.750
Cadmium, µg/l	--	10	10 (Health) 12 (Aquatic life softwater)
Chlorine	--	0.010	0.010
Chromium (Total)	0.05	--	0.050
Color (PCU)	--	--	75 (Health)
Copper	0.5	0.030	1.0
Cyanide (Total), µg/l	--	5	5
Detergents MBAS	0.5	--	--
Dissolved Oxygen (min.)	--	5	5.0
Fluoride	10.0	Marine Only	--
Hydrogen Sulfide	--	--	0.002
Iron	--	1.0	0.30
Lead	0.05	0.03	0.05
Manganese	--	--	0.05
Mercury, µg/l	--	0.2	2 (Health) 0.5 (Freshwater life)
Nickel	--	0.1	0.1
Nitrogen, Nitrate - N	--	--	10
Oils and Grease	5.0	--	0 (Domestic water, supply)
Pesticides/Herbicides Scan			
Aldrin - Dieldrin, µg/l	--	0.003	0.003
Chlordane, µg/l	--	0.01	0.01
2, 4 - D	--	--	0.10
2, 4, 5 TP µg/l	--	--	10
DDT, µg/l	--	0.001	0.001
Demeton, µg/l	--	0.1	0.1
Endosulfan, µg/l	--	0.003	0.003
Endrin, µg/l	--	0.004	0.2 (Health) 0.004 (Aquatic life)
Guthion, µg/l	--	0.01	0.01
Heptachlor, µg/l	--	0.001	1.0
Lindane, µg/l	--	0.1	4.0 (Health) 0.01 (Freshwater life)
Malathion, µg/l	--	0.1	0.1
Methoxychlor, µg/l	--	0.03	0.03
Mirex, µg/l	--	0.001	0.001
Parathion, µg/l	--	0.04	0.04
Toxaphene, µg/l	--	0.005	0.005
pH	6.0-8.5	6.0-8.5	6.5-9.0
Phenols	0.001	--	--
Phthalate Esters	--	0.003	0.003
Phosphate, Total as P	--	--	0.050
Polychlorinated biphenyls µg/l	--	0.001	0.001
Radioactivity			
Gross - activity pCi/l[2]	15	--	--
Radium - 226 pCi/l	5	--	--
Radium - 228 pCi/l	5	--	--
Selenium	--	0.025	0.01
Silver µg/l	--	0.07	50
Specific Conductance µmho/cm	100% increase 500 max.	--	--
Total Suspended Solids	--	--	Note 2
Turbidity, JTU	50	--	--
Zinc	1.0	--	5

Note: All Concentrations are in milligrams/liter unless otherwise noted.

1 Sufficiently low to keep dissolved oxygen within limits.
2 Ten percent maximum reduction in compensation depth from seasonal norm.

TABLE 7-2

AVERAGE MONTHLY FLOWS AT THE PEACE RIVER GAUGING STATIONS

	Average Monthly Flows (cfs)	
Month 1979-80	WL-7[a]	WL-8[b]
June	408	505
July	231	389
August	439	662
September	958	1508
October	840	1273
November	125	-
December	92	181
January	173	254
February	222	337
March	179	343

- No Data Available

(a) Means determined by adjusting the USGS Fort Meade gauging station data by the additional drainage area influent at Station WL-7.

(b) Means determined from daily averages monitored with a continuous recorder.

SOURCE: STUDY DATA

TABLE 7-3

PEACE RIVER FLOW
AT FORT MEADE USGS STATION #02294898

Water Year		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Annual
		Discharge in Cubic Feet Per Second (cfs)												
1974*	mean									140	352	409	320	
	max									428	514	488	436	
	min									40	209	299	208	
1974-75	mean	82.8	69.7	60.3	64.8	40.1	27.2	11.9	22.4	55.1	66.1	131	147	65.0
	max	197	134	103	88	95	46	36	80	291	138	252	439	439
	min	46	45	43	46	25	9.9	6.1	7.1	7.2	17	73	103	6.1
1975-76	mean	172	106	76.6	52.4	49.5	23.0	28.3	106	207	243	383	336	149
	max	271	156	130	130	75	48	67	332	305	410	509	443	509
	min	65	54	41	33	23	12	11	16	150	151	230	254	11
1976-77	mean	202	54.6	62.9	60.5	60.0	58.5	19.3	27.6	15.3	120	121	243	87.7
	max	336	125	86	100	86	99	45	95	70	372	219	437	437
	min	103	24	42	34	35	36	6.6	5.0	2.5	45	31	148	2.5
1977-78	mean	89.6	64.6	137	114	174	321	51.7	185	242	436	686	239	230
	max	212	127	246	188	428	502	120	324	347	769	877	494	877
	min	41	34	74	77	65	103	16	23	142	270	442	92	16
1978-79	mean	51.3	22.6	33.5	149	162	92	22	679	403	228	433	946	268
	max	104	53	95	250	270	186	41	1110	1155	321	600	1340	1340
	min	32	9.6	18	33	61	39	8.4	21	642	143	191	517	8.4
1979-80	mean	829	123	91	171	219	177	190	194	201	161	109	75	212
	max	1330	207	138	362	347	315	318	456	321	325	190	111	1330
	min	165	69	63	54	126	88	82	65	99	59	59	36	36

* Records begin in June 1974

SOURCE: USGS

TABLE 7-4

AVERAGE MONTHLY FLOWS FOR PEACE RIVER AT FORT MEADE AND WL-7

	Average Monthly Flows (cfs)	
Month	Fort Meade[a]	WL-7[b]
January	73	74
February	81	82
March	107	108
April	28	28
May	85	86
June	130	132
July	216	219
August	330	334
September	241	244
October	137	139
November	75	76
December	84	85
Annual Mean Flow	132	134
7-Day, 10-Year Low Flow	11	11
25-Year Flood Flow	5,800	5,871
100-Year Flood Flow	8,450	8,554

[a] Derived from USGS Station #02294898 data.
[b] Flows were calculated by increasing Fort Meade flows by 1 percent.

SOURCE: STUDY DATA

TABLE 7-5

WATER QUALITY DATA SUMMARIES FOR PEACE RIVER-STATIONS WQ-7 AND FDER DATA COLLECTED AT COUNTY LINE ROAD

Parameter	WQ-7					FDER DATA (Station #25020008)				
	Max	Min	Avg	N	FE	Max	Min	Avg	N	FE
Water Level (ft)	5.72	2.79	4.20	3	-	-	-	-	-	-
Flow (cfs)	-	-	-	-	-	-	-	-	-	-
pH (units)	7.7	6.6	-	5	0	7.3	6.5	-	9	0
Carbon Alkalinity (mg/l $\mathrm{CaCO_3}$)	0	0	0	5	-	-	-	-	-	-
Bicarbonate Alkalinity (mg/l $\mathrm{CaCo_3}$)	52	21	42	5	0	-	-	-	-	-
Temperature (°C)	28	15	23.8	5	-	-	-	-	-	-
Dissolved Oxygen (mg/l)	8.4	3.3	4.93	4	3	8.1	3.4	5.45	8	4
Total Suspended Solids (mg/l)	40	10	28.2	5	-	-	-	-	-	-
Turbidity (NTU)	15.0	1.7	8.67	3	0	14.5	5.3	9.2	9	0
Total Dissolved Solids (mg/l)	174	142	162.7	3	-	-	-	-	-	-
Conductivity (umho/cm)	400	198	309.6	5	0	400	175	271.7	9	0
Total Hardness (mg/l $\mathrm{CaCO_3}$)	224	96	141.7	3	-	-	-	-	-	-
$\mathrm{BOD_5}$ (mg/l)	6.3	0.2	3.3	5	-	-	-	-	-	-
Orthophosphate (mg/l)	5.27	0.56	2.41	5	-	-	-	-	-	-
Total Phosphorus (mg/l)	5.28	0.58	2.51	5	5	9.77	0.85	3.57	9	9
Ammonia (mg/l)	0.61	0.17	0.33	5	-	-	-	-	-	-
Organic-N (mg/l)	2.5	0.5	1.76	5	-	-	-	-	-	-
Nitrate - N (mg/l)	1.8	0.4	1.0	5	0	1.414	-	-	-	-
Nitrite - N (mg/l)	0.07	0.02	0.04	5	-	-	-	-	-	-
Total Nitrogen (mg/l)	3.88	1.73	3.13	5	-	-	-	-	-	-
Chloride (mg/l)	29.8	14.7	19.6	5	-	20.4	12.0	16.5	9	-
Fluoride (mg/l)	2.4	0.77	1.39	5	2	2.23	1.35	1.73	3	2
Sulfate (mg/l)	130.2	28.7	56.0	5	2	169	32.2	85.3	3	-
Sulfide (mg/l)	1.40	0.3	0.7	3	-	-	-	-	-	-
Barium (mg/l)	<0.1	<0.1	<0.1	1	0	-	-	-	-	-
Cadmium (mg/l)	0.04	<0.01	<0.02	3	0	-	-	-	-	-
Chromium (mg/l)	<0.06	<0.05	<0.05	3	0	-	-	-	-	-
Copper (mg/l)	<0.03	<0.03	<0.03	3	0	-	-	-	-	-
Iron (mg/l)	0.67	0.08	0.40	3	2	-	-	-	-	-
Lead (mg/l)	0.07	<0.03	<0.05	3	2	-	-	-	-	-
Mercury (mg/l)	0.0035	<0.002	<0.0014	3	2	-	-	-	-	-
Nickel (mg/l)	<0.06	<0.06	<0.06	3	0	-	-	-	-	-
Selenium (mg/l)	<0.025	<0.025	<0.025	3	0	-	-	-	-	-
Silver (mg/l)	<0.03	<0.03	<0.03	1	0	-	-	-		-
Silica (mg/l)	3.10	1.60	2.3	3	-	-	-	-	-	-
Zinc (mg/l)	.044	.024	.031	3	0	-	-	-	-	-
Pesticide Scan (mg/l)	ND	ND	ND	3	0	-	-	-	-	-
Herbicide Scan (mg/l)	ND	ND	ND	3	0	-	-	-	-	-
Detergent MBAS (mg/l)	0.20	0.05	0.13	3	-	-	-	-	-	-
Oil & Grease (mg/l)	8.1	0.1	4.1	2	1	-	-	-	-	-
Total Gross Activity (pCi/l)	2.7	<0.8	<1.8	4	0	0.9	<0.9	<0.9	2	0
Radium Alpha Activity (pCi)	0.9	<0.6	<0.8	2	0	-	-	-	-	-
TOC mg/l)	67.1	39.5	50.4	3	-	20	8	17.6	5	-

Max - Maximum value occurring during study program
Min - Minimum value occurring during study program
Avg - Arithmetic average of monthly data
N - Number of data points evaluated
FE - Frequency of Exceedance with applicable Federal and state water quality criteria
ND - Non-Detectable

SOURCE: STUDY DATA

TABLE 7-6

PEACE RIVER MONTHLY MASS LOADINGS
FOR STATIONS WQ-7 AND WL-8[(a)]
(kg/day - May through December 1979)

WQ-7[(b)]

Parameter	May	June	July	Aug	Sept	Oct	Nov	Dec
Flow (cfs)	-	570	-	300	-	1670	-	130
Ammonia	-	293	-	448	-	696	-	83
Nitrate	-	1536	-	294	-	3682	-	573
Nitrite	-	56	-	15	-	286	-	6.4
Total Nitrogen	-	4399	-	2595	-	13666	-	1236
Total Phosphorus	-	2430	-	1499	-	11824	-	1682
Orthophosphate	-	2430	-	1286	-	11170	-	1678
Fluoride	-	1383	-	882	-	3150	-	764
Sulfate	-	40080	-	21683	-	179208	-	15256
Total Suspended Solids	-	39102	-	22785	-	163660	-	10192
Total Dissolved Solids	-	-	-	127890	-	703738	-	45227
Total Organic Carbon	-	-	-	29033	-	274540	-	14173
BOD_5	-	6145	-	4631	-	11865	-	860

WL-8[(c)]

Parameter	May	June	July	Aug	Sept	Oct	Nov	Dec
Flow (cfs)	-	-	260	475	1410	1145	-	202
Total Phosphorus	-	-	1236	4155	11227	2385	-	4835
Fluoride	-	-	860	-	-	-	-	-
Sulfate	-	-	3470	-	-	90331	-	-
Total Organic Carbon	-	-	12740	38405	-	-	-	5444

– No Data Available

(a) WQ-7 and WL-8 mass loadings do not represent the same day for each station. Mass loadings were calculated from a single monthly sample and a corresponding instantaneous flow.

(b) Flows were derived by adding the average daily USGS Fort Meade flows with Bowlegs Creek WL-2 flows and Maron Run WL-3 flows and adjusting for any drainage areas not included

(c) Water Quality data was collected by the Florida DER and therefore the parameter listing is not as extensive. Mass loadings were calculated using the average daily flows collected for the sampling date at Station WL-8.

SOURCE: STUDY DATA

TABLE 7-7

AVERAGE MONTHLY FLOWS
AT THE BOWLEGS CREEK GAUGING STATION

	Average Monthly Flows (cfs)*	
Month 1979-80	WL-1	WL-2
June	3.4	4.1
July	2.2	2.7
August	12.1	17.9
September	129.5	177.4
October	46.1	78.1
November	4.2	8.5
December	5.1	9.2
January	5.3	9.1
February	12.6	19.5
March	23.0	38.6

* Monthly means were calculated from daily averages of stations equipped with continuous recorders.

SOURCE: STUDY DATA

TABLE 7-8

CALCULATED MONTHLY FLOWS FOR BOWLEGS CREEK AT WL-1 AND WL-2

	Calculated Monthly Flows (cfs)	
	WL-1	WL-2
January	16	19
February	15	19
March	26	32
April	8	9
May	10	12
June	43	52
July	69	83
August	70	85
September	111	134
October	68	82
November	14	16
December	9	11
Annual Mean Flow	38	46
7-Day, 10-Year Low Flow	0	0
25-Year Flood Flow *	2880	
100-Year Flood Flow *	4600	

* Flood flows were calculated for the creek section between WL-1 and WL-2.

SOURCE: STUDY DATA

TABLE 7-9

FLOW CONTRIBUTION OF BOWLEGS CREEK TO THE PEACE RIVER

Month	Bowlegs Creek WL-2 cfs	Maron Run WL-3 cfs	Bowlegs Creek Combined Flow cfs	Peace River WL-7 cfs	Contribution to Peace River* %
January	19	0.5	19.5	74	20.9
February	19	0.5	19.5	82	19.2
March	32	0.9	32.9	108	23.2
April	9	0.3	9.3	28	24.9
May	12	0.3	12.3	86	12.5
June		1.4	53.4	132	40.5
July	83	2.3	85.3	219	28.0
August	85	2.3	87.3	334	20.7
September	134	3.7	137.7	244	36.1
October	82	2.2	84.2	139	37.7
November	16	0.5	16.5	76	17.8
December	11	0.3	11.3	85	11.7
Mean	46	1.3	47.3	137	26.1

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* Propps Branch enters below the flow station; percentages will be slightly higher than shown.

SOURCE: STUDY DATA

TABLE 7-10

WATER QUALITY CHARACTERISTICS FOR BOWLEGS CREEK JANUARY 1970 THROUGH DECEMBER 1976

Parameter	Maximum	Minimum	Average
Alkalinity (mg/l $CaCO_3$)	158.0	10.0	64
BOD_5 (mg/l)	3.6	1.1	2.0
D.O. (mg/l)	9.0	5.8	7.7*
Fluoride (mg/l)	1.6	0.3	1.0
Nitrate - N (mg/l)	2.20	<0.01	0.50
Ammonia-N (mg/l)	0.14	0.01	0.05
Organic-N (mg/l)	0.77	0.45	0.60
pH (units)	8.0	5.8	
Temperature (°C)	28.0	10.0	21.8
Turbidity (JTU)	1.8	1.8	1.8*

* Average derived from less than ten observations.

SOURCE: EPA, 1978

TABLE 7-11

WATER QUALITY DATA SUMMARIES FOR BOWLEGS CREEK - STATIONS WQ-1 AND WQ-2

Parameter	WQ-1 (upstream)					WQ-2 (downstream)				
	Max	Min	Avg	N	FE	Max	Min	Avg	N	FE
Water Level (ft)	4.42	0.70	1.73	8	-	4.68	1.99	2.98	7	-
Flow (cfs)	171.8	2.7	43.2	8	-	187	4.0	57.8	7	-
pH (units)	6.75	4.6	-	9	5	7.2	4.7	-	9	4
Carbon Alkalinity (mg/l) $CaCO_3$	0	0	0	9	-	0	0	0	9	-
Bicarbonate Alkalinity (mg/l) $CaCO_3$	8	1	3.8	7	7	10	0	4	9	9
Temperature (°C)	27.0	16.0	23.8	9	-	27	16	24.4	9	-
Dissolved Oxygen (mg/l)	9.35	3.9	6.56	8	2	10	4.3	6.75	8	2
Total Suspended Solids (mg/l)	14	1	6.7	9	-	27	1	8.3	9	-
Turbidity (NTU)	4.3	1.4	2.45	6	0	5.4	1.3	2.7	6	0
Total Dissolved Solids (mg/l)	152	38	110	6	-	154	88	117	6	-
Conductivity (umho/cm)	145	60	97	8	0	695	62	168	8	0
Total Hardness (mg/l) $CaCO_3$	52	20	32	6	-	48	20	31	6	-
BOD_5 (mg/l)	2.3	0.2	1.19	9	-	2.4	0.2	1.2	9	-
Orthophosphate (mg/l)	0.26	0.09	0.18	9	-	0.39	0.16	0.23	9	-
Total Phosphorus (mg/l)	0.38	0.12	0.22	9	9	0.88	0.18	0.34	9	9
Ammonia (mg/l)	0.60	0.07	0.24	9	-	0.7	<0.1	0.25	9	-
Organic-N (mg/l)	1.5	0.6	0.98	9	-	1.5	0.4	1	8	-
Nitrate-N (mg/l)	3.7	0.2	1.7	9	0	3.4	0.4	1.5	9	0
Nitrite-N (mg/l)	0.03	<0.01	<0.01	9	-	0.03	<0.01	<0.01	9	-
Total Nitrogen (mg/l)	4.93	1.49	2.94	9	-	4.53	1.53	2.71	9	-
Chloride (mg/l)	19.4	11.0	14.9	9	-	18.2	11.0	14.4	9	-
Fluoride (mg/l)	0.20	0.10	.15	9	0	0.20	0.12	0.1	9	0
Sulfate (mg/l)	20.6	2.4	12.2	9	-	17.5	3.0	12.5	9	-
Sulfide (mg/l)	1.2	0.1	0.7	6	-	1.3	0.1	0.72	6	-
Barium (mg/l)	<0.01	<0.01	-	3	0	<0.01	<0.01	<0.01	3	0
Cadmium (mg/l)	0.12	0.01	0.05	6	0	0.66	<0.01	<0.13	6	0
Chromium (mg/l)	0.07	<0.05	-	6	1	0.10	<0.05	<0.06	6	1
Copper	<0.03	<0.03	-	6	0	<0.03	<0.03	<0.03	6	0
Iron (mg/l)	0.74	0.12	0.44	6	5	0.73	0.10	0.47	6	5
Lead (mg/l)	0.04	<0.03	-	6	1	0.09	<0.03	<0.04	6	1
Mercury (mg/l)	0.0207	0.0008	0.0064	6	6	0.0188	<0.0002	0.0048	6	5
Nickel (mg/l)	20.9	<0.06	<3.5	6	1	<0.06	<0.06	<0.6	6	0
Selenium (mg/l)	0.037	<0.005	<0.024	6	1	0.044	<0.005	<0.028	6	2
Silver (mg/l)	<0.03	<0.03	<0.03	3	0	<0.03	<0.03	<0.03	3	0
Silica (mg/l)	7.8	0.9	4.1	6	-	7.9	0.8	3.7	6	-
Zinc (mg/l)	0.088	0.025	0.052	6	0	0.095	0.025	0.048	6	0
Pesticide Scan (mg/l)	ND	ND	ND	6	0	ND	ND	ND	6	0
Herbicide Scan (mg/l)	ND	ND	ND	6	0	ND	ND	ND	6	0
Detergent MBAS (mg/l)	0.20	0.04	0.13	6	-	0.19	0.10	.14	6	-
Oil & Grease (mg/l)	1.2	<0.01	0.38	4	0	0.5	<0.1	<0.2	4	0
Total Gross Alpha Activity (pCi)	5.0	1.1	2.7	8	0	3.4	<1.0	<0.2	8	0
Radium Alpha Activity (pCi)	5.7	<1.0	<2.5	5	1	2.6	<1.1	<1.8	2	0
TOC (mg/l)	71.4	29.1	48.5	6	-	64.4	32.0	46.4	6	-

Max - Maximum value occurring during study program
Min - Minimum value occurring during study program
Avg - Arithmetic average of monthly data
N - Number of data points evaluated
FE - Frequency of Exceedance with applicable Federal and state water quality criteria
ND - Non-Detectable

SOURCE: STUDY DATA

TABLE 7-12

MONTHLY AND MEAN MASS LOADINGS FOR BOWLEGS CREEK AT STATION WQ-2 AND RELATIVE LOADING TO THE PEACH RIVER

Mass Loading, Station WQ-2*

Parameter	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Flow (cfs)	187.0	-	5.0	4.0	167.0	22.0	12.0	7.3	-
Ammonia	201.6	-	2.6	1.2	36.8	11.3	9.4	2.9	38.0
Nitrate	229.1	-	25.8	9.8	163.7	21.6	50.0	46.5	78.1
Nitrite	4.6	-	<0.12	0.10	8.18	1.08	0.29	0.18	2.08
Total Nitrogen	898.1	-	39.5	19.8	822.5	82.5	80.3	60.3	286.1
Total Phosphorus	210.8	-	3.0	2.5	360.1	19.9	6.2	3.4	86.6
Orthophosphate	174.1	-	3.4	2.3	143.2	15.1	5.0	2.9	49.4
Fluoride	73.3	-	2.0	1.5	61.4	10.8	5.0	2.1	22.3
Sulfate	7927	-	182.0	112.7	7161	851.6	88.2	177.2	2357.1
Total Suspended Solids	458.2	-	196.8	166.6	2046	53.9	117.6	35.8	439.3
Total Dissolved Solids	-	-	1722	862.4	63016	5713	2852	2076	12707
Total Organic Carbon	-	-	568.3	371.4	25370	3471	1046.6	572.8	5233
BOD_5	733.1	-	2.5	23.5	327.4	102	23.5	21.5	176.2

Relative Loading of Bowlegs Creek to the Peace River (percentage)

Parameter	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ammonia	-	-	-	0.3	-	1.6	-	3.5
Nitrate	-	-	-	3.3	-	0.6	-	8.1
Nitrite	-	-	-	0.7	-	0.4	-	2.9
Total Nitrogen	-	-	-	0.8	-	0.6	-	4.9
Total Phosphorus	-	-	-	0.2	-	0.2	-	0.2
Orthophosphate	-	-	-	0.2	-	0.1	-	0.2
Fluoride	-	-	-	0.2	-	0.3	-	0.3
Sulfate	-	-	-	0.5	-	0.5	-	1.2
Total Suspended Solids	-	-	-	0.7	-	<0.1	-	0.4
Total Dissolved Solids	-	-	-	0.7	-	0.8	-	4.6
Total Organic Carbon	-	-	-	1.3	-	1.3	-	4.1
BOD_5	-	-	-	0.5	-	0.9	-	2.5

- No Data Available

* Mass loadings were calculated from a single monthly sample and a corresponding instantaneous flow (values in kg/day).

SOURCE: STUDY DATA

TABLE 7-13

AVERAGE MONTHLY FLOWS FOR ON-SITE TRIBUTARIES WITH STREAM GAUGING STATIONS

	Average Monthly Flows (cfs)				
Month 1979-80	WL-3 Maron Run	WL-4 Stephens Branch	WL-5 Gilshey Branch	WL-10 Gurr Run	WL-11 Bowlegs Tributary
June	0.14	0.24	0.26	0	-
July	0.13	0.44	0.24	0	-
August	0.63	0.49	0.93	0	-
September	6.30	3.09	8.10	0.067	1.40
October	0.62	2.25	0.48	0	4.00
November	0.08	0.46	0.24	0	0.53
December	0.16	0.38	0.26	0	0.49
January	0.24	0.44	0.27	0	0.45
February	0.25	0.43	0.36	0	0.46
March	0.78	0.68	-	0	0.45

- No Data Available

SOURCE: STUDY DATA

TABLE 7-14

AVERAGE MONTHLY FLOWS
CALCULATED FOR SELECTED ON-SITE TRIBUTARIES
(cfs)

	Maron Run WL- 3	Stephens Branch WL- 4	Gilshey Branch WL- 5	West Trib to Parker WL- 6	East Trib to Parker WL- 9	Garr Run WL- 10	Cypress Area WL- 11
January	0.5	0.4	1.0	1.1	1.0	0.4	0.3
February	0.5	0.4	0.9	1.1	1.0	0.4	0.3
March	0.9	0.7	1.6	1.8	1.6	0.6	0.6
April	0.3	0.2	0.5	0.5	0.5	0.2	0.2
May	0.3	0.3	0.6	0.7	0.6	0.2	0.2
June	1.4	1.2	2.6	2.9	2.7	1.0	0.9
July	2.3	1.9	4.1	4.7	4.3	1.6	1.5
August	2.3	1.9	4.2	4.8	4.4	1.6	1.5
September	3.7	3.0	6.7	7.6	6.9	2.6	2.3
October	2.2	2.2	4.1	4.6	4.2	1.6	1.4
November	0.5	0.4	0.8	0.9	0.8	0.3	0.3
December	0.3	0.3	0.6	0.6	0.6	0.2	0.2
Annual Mean Flow	1.3	1.1	2.3	2.6	2.4	0.9	0.2
7-Day 10-Year Low Flow	0	0	0	0	0	0	0
25-Year Flood Flow	310	922	1626	-	-	870	-
100-Year Flood Flow	400	1216	2135	-	-	1140	-

- No Data Available

SOURCE: STUDY DATA

TABLE 7-15

AVERAGE MONTHLY FLOW CONTRIBUTION OF TRIBUTARIES TO THE PEACE RIVER

Month	Combined Peace River Flow (WL-7, WL-2, WL-3)	Gurr, Stephens and Gilshey	Flow Contribution to Peace River
January	93.5 cfs	1.9 cfs	2.0%
February	101.5	1.7	1.6
March	140.9	2.9	2.0
April	37.3	0.9	2.4
May	98.3	1.1	1.1
June	185.4	4.8	2.5
July	304.3	7.6	2.4
August	421.3	7.7	1.8
September	381.7	12.3	3.1
October	223.2	7.9	3.4
November	92.5	1.5	1.6
December	96.3	1.1	1.1
Mean	181.3	4.3	2.3

Note: Propps Branch and Whidden Creek enter below flow stations; therefore, percentages will be lower than shown.

SOURCE: STUDY DATA

TABLE 7-16

FLOW CONTRIBUTION OF TRIBUTARIES TO BOWLEGS CREEK BETWEEN WL-1 AND WL-2

Month	WL-1	WL-2	Difference	Tributary Contribution after Bank Seepage Adjustment*	Relative Flow to Bowlegs Creek
January	16 cfs	19 cfs	3 cfs	1.8 cfs	9.5%
February	15	19	4	2.4	12.6
March	26	32	6	3.6	11.2
April	8	9	1	0.6	6.7
May	10	12	2	1.2	10.0
June	43	52	9	5.5	10.6
July	69	83	14	8.5	10.2
August	70	85	15	9.1	10.7
September	111	134	23	14.0	10.4
October	68	82	14	8.5	10.4
November	14	16	2	1.2	7.5
December	9	11	2	1.2	10.9
Mean	38.2	46.2	8.0	4.8	10.1

* Ratio of distance between WL-1 and WL-2 to cumulative length of tributaries = 7.25:11.25.

SOURCE: STUDY DATA

TABLE 7-17

AVERAGE MONTHLY FLOW CONTRIBUTION OF MARON RUN TO BOWLEGS CREEK AT WL-2

Month	WL-2	Maron Run	Flow Contribution to Bowlegs Creek
January	19 cfs	0.5 cfs	2.6%
February	19	0.5	2.6
March	32	0.9	2.7
April	9	0.3	3.2
May	12	0.3	2.4
June	52	1.4	2.6
July	83	2.3	2.7
August	85	2.3	2.6
September	134	3.7	2.7
October	82	2.2	2.6
November	16	0.5	3.0
December	11	0.3	2.7
Mean	46.2	1.3	2.7

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* Percent increase in flow at WL-2. Does not take into account bank seepage and Propps Branch.

SOURCE: STUDY DATA

TABLE 7-18

WATER QUALITY DATA SUMMARIES FOR GILSHEY BRANCH - STATION WQ-5

Parameter	Max	Min	Avg	N
Water Level (ft)	1.72	0	1.06	6
Flow (cfs)	3.82	0	0.68	6
pH (units)	7.5	6.2	-	8
Carbonate Alkalinity (mg/l $CaCO_3$)	0	0	0	8
Bicarbonate Alkalinity (mg/l $CaCO_3$)	74	6	23.3	7
Temperature (°C)	28	17	23.3	8
Dissolved Oxygen (mg/l)	8.0	4.8	6.33	7
Total Suspended Solids (mg/l)	30	2	8.8	7
Turbidity (NTU)	3.5	1.1	2.6	5
Total Dissolved Solids (mg/l)	206	116	163.4	5
Conductivity (μ mho/cm)	260	100	155	8
Total Hardness (mg/l $CaCO_3$)	68	32	53	5
BOD_5 (mg/l)	2.5	0.2	1.1	8
Orthophosphate (mg/l)	1.69	0.58	1.17	8
Total Phosphorus (mg/l)	2.07	0.67	1.28	8
Ammonia (mg/l)	0.64	0.09	0.27	7
Organic-N (mg/l)	1.4	0.2	0.69	7
Nitrate-N (mg/l)	0.9	0.2	0.45	8
Nitrite -N (mg/l)	0.02	<0.01	<0.01	8
Total Nitrogen (mg/l)	1.92	0.92	1.36	8
Chloride (mg/l)	46.5	14.2	22.3	8
Fluoride (mg/l)	0.84	0.34	0.46	8
Sulfate (mg/l)	51.1	8.3	21.9	8
Sulfide (mg/l)	1.2	0.1	0.6	5
Barium (mg/l)	<0.1	<0.01	<0.1	2
Cadmium (mg/l)	0.05	<0.01	<0.03	5
Chromium (mg/l)	0.15	<0.05	<0.07	5
Copper (mg/l)	<0.03	<0.03	<0.03	5
Iron (mg/l)	1.25	0.29	0.77	5
Lead (mg/l)	0.09	<0.03	<0.04	5
Mercury (mg/l)	0.0132	<0.0002	0.0053	5
Nickel (mg/l)	<0.06	<0.06	<0.06	5
Selenium (mg/l)	0.046	<0.005	<0.029	5
Silver (mg/l)	<0.03	<0.03	<0.03	2
Silica (mg/l)	10.9	1.9	4.74	5
Zinc (mg/l)	0.092	0.015	0.048	5
Pesticide Scan (mg/l)	ND	ND	ND	5
Herbicide Scan (mg/l)	ND	ND	ND	5
Detergent MBAS (mg/l)	0.19	0.05	.12	5
Oil & Grease (mg/l)	3.0	<0.01	<1.0	3
Total Gross Alpha Activity (pCi/l)	1.7	<0.6	<1.2	7
Radium Alpha Activity Activity (pCi/l)	1.2	1.2	1.2	1
TOC (mg/l)	72.6	32.6	47.3	5

Max - Maximum value occurring during study program

Min - Minimum value occurring during study program

Avg - Arithmetic average of monthly data

N - Number of data points evaluated

ND - Non-Detectable

SOURCE: STUDY DATA

TABLE 7-19

WATER QUALITY DATA SUMMARIES FOR GURR RUN
STATION WQ-8

Parameter	Max	Min	Avg	N
Water Level (ft)	4.93	4.93	-	1
Flow (cfs)	713	713	-	1
pH (units)	7.1	6.3	-	3
Carbonate Alkalinity (mg/l $CaCO_3$)	0	0	0	3
Bicarbonate Alkalinity (mg/l $CaCO_3$)	50	8	24.6	3
Temperature (°C)	24	17	21	3
Dissolved Oxygen (mg/l)	6.5	1.2	4.7	3
Total Suspended Solids (mg/l)	96	3	41	3
Turbidity (NTU)	27	1.6	11.3	3
Total Dissolved Solids (mg/l)	254	126	190	3
Conductivity (umho/cm)	200	160	138.7	3
BOD_5 (mg/l)	1.7	1.4	1.5	3
Orthophosphate (mg/l)	2.78	0.77	1.59	3
Total Phosphorus (mg/l)	3.39	0.79	1.82	3
Ammonia (mg/l)	0.26	0.18	0.23	3
Organic-N (mg/l)	2.7	0.5	1.3	3
Nitrate-N (mg/l)	1.1	0.4	0.77	3
Nitrite-N (mg/l)	0.4	0.01	0.02	3
Total Nitrogen (mg/l)	3.38	1.69	2.31	3
Chloride (mg/l)	29.8	22.3	25.0	3
Fluoride (mg/l)	0.56	0.36	0.46	3
Sulfate (mg/l)	20.4	11.6	15.4	3
Total Gross Alpha Activity (pCi/l)	5.5	1.3	3.4	2
Radium Alpha Activity (pCi/l)	3.4	1.0	2.2	2
TOC (mg/l)	69.3	22.7	39.9	3

Max - Maximum value occurring during study program
Min - Minimum value occurring during study program
Avg - Arithmetic average of monthly data
N - Number of data points evaluated

SOURCE: STUDY DATA

TABLE 7-20

WATER QUALITY DATA SUMMARIES
FOR STEPHENS BRANCH - STATION WQ-4

Parameter	Max	Min	Avg	N
Water Level (ft)	0.43	0.18	0.39	7
Flow (cfs)	0.50	0.02	0.34	7
pH (units)	6.8	5.4	-	9
Carbonate Alkalinity (mg/l $CaCO_3$)	0	0	0	9
Bicarbonate Alkalinity (mg/l $CaCO_3$)	11	6	7.9	9
Temperature (°C)	24.5	17	22.2	9
Dissolved Oxygen (mg/l)	7.9	5.2	6.23	7
Total Suspended Solids (mg/l)	20	2	8.6	9
Turbidity (NTU)	11	0.8	3.8	6
Total Dissolved Solids (mg/l)	260	90	126.8	6
Conductivity (μ mho/cm)	140	80	101.3	8
Total Hardness (mg/l $CaCO_3$)	48	28	37	6
BOD_5 (mg/l)	4.7	<0.1	1.7	9
Orthophosphate (mg/l)	1.04	0.64	0.83	9
Total Phosphorus (mg/l)	1.45	0.64	0.94	9
Ammonia (mg/l)	0.5	0.07	<0.21	9
Organic-N (mg/l)	1.6	0.2	0.82	9
Nitrate-N (mg/l)	2.0	0.6	1.16	9
Nitrite -N (mg/l)	0.01	<0.01	<0.01	9
Total Nitrogen (mg/l)	3.0	1.51	2.19	9
Chloride (mg/l)	22.5	13.9	17.3	9
Fluoride (mg/l)	0.46	0.27	0.37	9
Sulfate (mg/l)	13.8	2.6	8.8	9
Sulfide (mg/l)	1.2	0.1	0.67	6
Barium (mg/l)	<0.1	<0.01	<0.01	3
Cadmium (mg/l)	0.06	<0.01	<0.02	6
Chromium (mg/l)	0.13	<0.05	<0.07	6
Copper (mg/l)	0.32	<0.03	<0.03	6
Iron (mg/l)	0.72	0.17	0.44	6
Lead (mg/l)	0.16	<0.03	<0.05	6
Mercury (mg/l)	0.0075	<0.0002	0.0025	6
Nickel (mg/l)	<0.06	<0.06	<0.06	6
Selenium (mg/l)	0.053	<0.005	<0.032	6
Silver (mg/l)	<0.03	<0.03	<0.03	3
Silica (mg/l)	7.5	1.2	4.18	6
Zinc (mg/l)	0.086	0.020	0.042	6
Pesticide Scan (mg/l)	ND	ND	ND	6
Herbicide Scan (mg/l)	ND	ND	ND	6
Detergent MBAS (mg/l)	0.25	0.07	0.16	6
Oil & Grease (mg/l)	6.4	<0.1	2.8	4
Total Gross Alpha Activity (pCi/l)	3.0	0.8	<1.6	7
Radium Alpha Activity (pCi/l)	2.8	2.0	2.4	2
TOC (mg/l)	53.0	16.9	32.6	6

Max - Maximum value occurring during study program

Min - Minimum value occurring during study program

Avg - Arithmetic average of monthly data

N - Number of data points evaluated

ND - Non-Detectable

SOURCE: STUDY DATA

TABLE 7-21

WATER QUALITY DATA SUMMARIES FOR MARON RUN
STATION WQ-3

Parameter	Max	Min	Avg	N
Water Level (ft)	1.22	0.99	1.07	7
Flow (cfs)	0.55	0.05	0.17	7
pH (units)	7.2	5.9	-	9
Carbonate Alkalinity (mg/l $CaCO_3$)	0	0	0	9
Bicarbonate Alkalinity (mg/l $CaCO_3$)	58	13	30.4	9
Temperature (°C)	26	15	22.7	9
Dissolved Oxygen (mg/l)	6.6	3.5	4.6	8
Total Suspended Solids (mg/l $CaCO_3$)	11	2	8.6	9
Turbidity (NTU)	2.2	0.5	1.36	6
Total Dissolved Solids (mg/l $CaCO_3$)	274	92	145	6
Conductivity (μ mho/cm)	160	60	116.8	8
Total Hardness (mg/l $CaCO_3$)	72	34	51	6
BOD_5 (mg/l)	2.1	<0.1	0.98	9
Orthophosphate (mg/l)	0.98	0.49	0.72	9
Total Phosphorus (mg/l)	0.98	0.49	0.74	9
Ammonia (mg/l)	0.4	<0.1	<0.16	9
Organic-N (mg/l)	1.3	0.2	0.62	9
Nitrate-N (mg/l)	0.3	0.1	0.16	9
Nitrite-N (mg/l)	0.01	<0.01	<0.01	9
Total Nitrogen (mg/l)	1.69	0.30	0.90	9
Chloride (mg/l)	15.6	7.8	11.7	9
Fluoride (mg/l)	0.48	.21	0.36	9
Sulfate (mg/l)	14.2	1.6	7.9	9
Sulfide (mg/l)	1.2	0.2	0.65	9
Barium (mg/l)	<0.1	<0.1	<0.1	3
Cadmium (mg/l)	0.28	<0.01	<0.07	6
Chromium (mg/l)	0.11	<0.05	<0.06	6
Copper (mg/l)	<0.03	<0.03	<0.03	6
Iron (mg/l)	0.92	0.23	0.50	6
Lead (mg/l)	0.09	<0.03	<0.04	6
Mercury (mg/l)	0.0169	<0.0002	<0.0044	6
Nickel (mg/l)	0.10	<0.06	<0.07	6
Selenium (mg/l)	0.025	<0.005	<0.022	6
Silver (mg/l)	<0.03	<0.03	<0.03	3
Silica (mg/l)	11.3	1.0	6.3	6
Zinc (mg/l)	0.131	0.032	0.056	6
Pesticide Scan (mg/l)	ND	ND	ND	6
Herbicide Scan (mg/l)	ND	ND	ND	6
Detergent MBAS (mg/l)	0.17	0.10	0.16	6
Oil & Grease (mg/l)	2.5	<0.1	<0.7	6
Total Gross Alpha Activity (pCi/l)	1.3	<0.6	<1.0	8
Radium Alpha Activity (pCi/l)	<1.0	<1.0	<1.0	1
TOC (mg/l)	66.4	37.4	47.2	6

Max - Maximum value occurring during study program

Min - Minimum value occurring during study program

Avg - Arithmetic average of monthly data

N - Number of data points evaluated

ND - Non-Detectable

SOURCE: STUDY DATA

TABLE 7-22

WATER QUALITY DATA SUMMARIES
FOR STATION WQ-6

Parameter	Max	Min	Avg	N
Water Level (ft)	8.64	7.10	7.52	5
pH (units)	6.4	5.6	-	6
Carbonate Alkalinity ($mg/l\ CaCO_3$)	0	0	0	6
Bicarbonate Alkalinity ($mg/l\ CaCO_3$)	12	2	7.5	6
Temperature (°C)	33	24.5	26.9	6
Dissolved Oxygen (mg/l)	4.8	2.3	3.6	6
Total Suspended Solids (mg/l)	22	2	8.5	6
Turbidity (NTU)	2.7	0.5	1.5	4
Total Dissolved Solids (mg/l)	314	120	177	4
Conductivity (umho/cm)	118	68	85.8	5
Total Hardness ($mg/l\ CaCO_3$)	40	22	29.6	5
BOD_5 (mg/l)	3.4	0.7	1.98	6
Orthophosphate (mg/l)	0.73	0.25	0.42	6
Total Phosphorus (mg/l)	0.86	0.30	0.5	6
Ammonia (mg/l)	0.54	<0.10	<0.21	6
Organic-N (mg/l)	1.9	0.4	1.18	6
Nitrate-N (mg/l)	0.4	0.1	0.28	6
Nitrite-N (mg/l)	0.02	<0.01	<0.01	6
Total Nitrogen (mg/l)	2.36	0.8	1.67	6
Chloride (mg/l)	19.7	13.1	16.6	6
Fluoride (mg/l)	0.24	0.17	0.21	6
Sulfate (mg/l)	16.8	4.0	13.3	6
Sulfide (mg/l)	1.3	0.1	0.82	5
Barium (mg/l)	<0.1	<0.01	<0.1	3
Cadmium (mg/l)	0.03	<0.01	<0.02	5
Chromium (mg/l)	0.13	<0.05	<0.07	5
Copper (mg/l)	<0.03	<0.03	<0.03	5
Iron (mg/l)	0.77	0.27	0.6	5
Lead (mg/l)	0.11	<0.03	<0.05	5
Mercury (mg/l)	0.009	0.0002	0.0034	5
Nickel (mg/l)	<0.06	<0.06	<0.06	5
Selenium (mg/l)	0.031	<0.005	<0.022	5
Silver (mg/l)	<0.03	<0.03	<0.03	3
Silica (mg/l)	4.7	0.7	2.18	5
Zinc (mg/l)	0.062	0.023	.035	5
Pesticide Scan (mg/l)	ND	ND	ND	5
Herbicide Scan (mg/l)	ND	ND	ND	5
Detergent MBAS (mg/l)	0.46	0.08	0.23	5
Oil & Grease (mg/l)	13.3	<0.01	<3.7	4
Total Gross Alpha Activity (pCi/l)	3.1	<0.8	<1.4	7
Radium Alpha Activity (pCi/l)	<1.0	<1.0	<1.0	1
TOC (mg/l)	68.4	56.9	62.5	4

Max - Maximum value occurring during study program

Min - Minimum value occurring during study program

Avg - Arithmetic average of monthly data

N - Number of data points evaluated

ND - Non-Detectable

SOURCE: STUDY DATA

TABLE 7-23

WATER QUALITY DATA SUMMARIES
FOR STATION WQ-9

Parameter	Max	Min	Avg	N
Water Level (ft)	1.04	0.31	0.68	2
pH (units)	6.1	6.0	6.1	2
Carbonate Alkalinity (mg/l $CaCo_3$)	0	0	0	2
Bicarbonate Alkalinity (mg/l $CaCO_3$)	16	10	13	2
Temperature (°C)	25.2	25	25.1	2
Dissolved Oxygen (mg/l)	2.4	1.0	1.7	2
Total Suspended Solids (mg/l $CaCO_3$)	9	2	5.5	2
Turbidity (NTU)	2.2	2.2	2.2	1
Total Dissolved Solids (mg/l $CaCO_3$)	150	150	150	1
Conductivity (μ mho/cm)	160	150	155	2
Total Hardness (mg/l Ca CO_3)	20	20	20	1
BOD_5 (mg/l)	3.2	0.8	2.0	2
Orthophosphate (mg/l)	0.87	0.32	0.60	2
Total Phosphorus (mg/l)	1.06	0.37	0.72	2
Ammonia (mg/l)	0.42	0.09	0.26	2
Organic-N (mg/l)	1.4	1.0	1.2	2
Nitrate-N (mg/l)	0.5	0.4	0.45	2
Nitrite-N (mg/[illegible]	0.02	0.01	0.02	2
Total Nitrogen [illegible]g/l)	1.93	1.91	1.92	2
Chloride (mg/l)	16.3	13.6	15.0	2
Fluoride (mg/l)	0.17	0.17	0.17	2
Sulfate (mg/l)	52.0	36.2	44.1	2
Sulfide (mg/l)	1.2	1.2	1.2	1
Cadmium (mg/l)	0.03	0.03	0.03	1
Chromium (mg/l)	0.15	0.15	0.15	1
Copper (mg/l)	<0.03	<0.03	<0.03	1
Iron (mg/l)	0.57	0.57	0.57	1
Lead (mg/l)	0.08	0.08	0.08	1
Mercury (mg/l)	0.0039	0.0039	0.0039	1
Nickel (mg/l)	<0.06	<0.06	<0.06	1
Selenium (mg/l)	<0.025	<0.025	<0.025	1
Silica (mg/l)	4.4	4.4	4.4	1
Zinc (mg/l)	0.026	0.026	0.026	1
Pesticide Scan (mg/l)	ND	ND	ND	1
Herbicide Scan (mg/l)	ND	ND	ND	1
Detergent MBAS (mg/l)	0.11	0.11	0.11	1
Total Gross Alpha Activity (pCi/l)	1.2	0.8	1.0	2
TOC (mg/l)	57.9	57.9	57.9	1

Max - Maximum value occurring during study program

Min - Minimum value occurring during study program

Avg - Arithmetic average of monthly data

N - Number of data points evaluated

ND - Non-Detectable

SOURCE: STUDY DATA

TABLE 7-24

ADDITIONAL WATER QUALITY DATA AT SELECTED STATIONS ON GILSHEY BRANCH

Station	River Mile	Alkalinity (mg/1 as CaCO$_3$)	Acidity (mg/1 as CaCO$_3$)	pH (units)	Conductivity (umhos/cm at 25^{o}C)	Color (pt/Co units)	Tannin/Lignin (mg/1)	Fluoride (mg/1)	Calcium (mg/1)	Total Phosphorus (mg/1)	Ortho-phosphate (mg/1)	Total Organic Carbon (mg/1)	Nitrate/Nitrite Nitrogen (mg/1)	Ammonia Nitrogen (mg/1)	Total Kjeldahl Nitrogen (mg/1)	Notes
PR-1	0.00	59.0	7.0	7.4	346	80	1.48	1.64	36.1	4.20	4.20	117.1	0.87	0.05	2.25	1
GB-3	0.04	41.0	10.0	6.9	186	110	2.26	0.60	22.0	1.18	1.22	40.9	0.80	0.02	0.56	
GB-6	0.20	32.0	8.5	7.0	167	120	2.58	0.53	16.6	1.28	1.25	49.4	0.93	0.01	0.69	
GB-9	0.35	28.0	6.0	6.8	186	130	2.63	0.50	17.6	1.30	1.20	28.2	1.40	0.02	0.81	
GB-14A	0.44	27.0	6.0	7.1	189	65	1.44	0.75	21.2	0.80	1.95	89.5	0.38	0.01	2.52	2
GB-17	0.65	16.8	6.0	6.8	148	140	3.07	0.51	13.0	1.58	1.43	100.0	0.23	0.01	1.59	3
GB-17	0.65	16.4	7.0	6.8	142	140	3.03	0.52	14.8	1.56	1.54	104.0	0.20	0.04	2.08	4
GB-18A	0.67	3.2	3.5	6.4	147	12	0.16	0.23	17.6	0.51	0.51	57.4	1.92	<0.01	0.03	2
GB-22	0.86	29.0	5.0	7.0	144	110	2.48	0.44	16.8	1.58	1.50	57.1	0.02	0.01	0.67	5
BG-23	0.86	10.4	8.0	6.4	134	190	3.60	0.52	11.2	1.54	1.44	73.9	0.01	<0.01	0.67	6
GB-25	1.19	9.2	6.0	6.5	151	190	3.57	0.50	12.0	1.26	1.11	67.9	0.11	0.01	0.71	2
GB-25A	1.19	0.0	20.0	4.1	80	460	7.16	0.34	4.0	1.28	1.08	84.5	0.03	0.01	0.71	7
GB-25B	1.19	0.0	19.0	4.2	83	460	6.92	0.35	3.4	1.02	0.93	86.6	0.03	0.01	1.87	
GB-28	1.62	3.0	6.0	5.9	83	120	2.51	0.41	5.2	0.60	0.82	59.9	0.01	0.01	1.09	
GB-29	1.71	11.0	7.0	6.4	217	240	4.44	0.54	19.6	1.22	1.13	47.3	0.02	0.01	0.96	
GB-30	1.83	8.8	4.0	7.0	101	22	0.68	0.44	7.2	1.45	1.43	15.9	0.03	<0.01	0.33	
GB-32	2.00	14.0	5.0	6.9	239	200	4.32	0.47	20.4	1.06	1.06	82.6	0.03	0.01	1.04	
GB-33	2.19	13.0	4.0	6.9	196	65	1.64	0.44	15.2	0.46	0.51	67.9	0.11	0.01	0.29	
GB-34	2.57	11.6	7.0	6.7	146	420	9.08	0.27	9.5	0.85	0.85	103.6	0.05	0.08	3.48	
GB-41.1	0.99	33.0	6.5	7.4	198	120	2.84	0.44	16.8	0.92	1.12	97.0	0.03	0.01	0.73	8
GB-41	0.99	25.0	9.5	6.8	222	300	6.68	0.44	20.8	1.88	1.87	148.8	0.04	0.04	2.04	
GB-40A	1.05	28.0	9.0	6.6	220	300	6.56	0.43	21.6	2.04	1.81	73.9	0.05	0.07	2.25	2
GB-37	1.60	23.0	9.0	6.6	143	300	7.76	0.41	12.7	1.96	1.85	59.7	0.03	0.04	1.20	
GB-36	2.24	37.0	7.0	6.7	150	22	0.53	0.57	14.4	0.31	0.63	57.8	0.01	0.02	0.23	
GB-35	2.49	66.0	5.0	7.7	268	120	2.56	0.34	31.3	0.07	0.10	59.2	0.03	0.01	1.48	

[1] Peace River at confluence

[2] Off-channel input

[3] Bridge at road

[4] Duplicate

[5] North Fork

[6] South Fork (Start Series)

[7] Isolated pool

[8] North Fork (Start Series)

SOURCE: STUDY DATA

TABLE 7-25

ADDITIONAL WATER QUALITY DATA AT SELECTED STATIONS ON MARON RUN

Station	River Mile	Alkalinity (mg/l as $CaCO_3$)	Acidity (mg/l as $CaCO_3$)	pH (units)	Conductivity (umhos/cm at 25°C)	Color (pt/Co units)	Tannin/Lignin (mg/l)	Fluoride (mg/l)	Calcium (mg/l)	Total Phosphorus (mg/l)	Ortho-phosphate (mg/l)	Total Organic Carbon (mg/l)	Nitrate/Nitrite Nitrogen (mg/l)	Ammonia Nitrogen (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Notes
BC-1	0.0	5.4	5.0	6.6	113	160	3.46	0.14	12.0	0.16	0.14	55.6	1.82	0.02	0.79	1
MR-1	0.0	38.0	10.0	7.3	139	80	1.69	0.40	16.0	0.68	0.66	60.4	0.03	<0.01	0.45	2
MR-2	0.05	42.0	5.0	7.3	135	85	1.64	0.40	14.4	0.70	0.70	74.9	0.07	<0.01	0.33	
MR-5	0.19	41.0	4.0	7.2	142	80	1.65	0.41	14.4	0.70	0.71	76.7	0.06	<0.01	0.26	
MR-7	0.34	43.0	7.0	7.1	177	80	1.47	0.39	14.4	0.59	0.60	82.5	0.12	0.01	0.29	
MR-7A	0.34	56.0	12.0	7.0	145	380	6.59	0.59	28.9	0.50	0.55	80.5	0.03	0.01	1.42	3
MR-9	0.44	46.0	6.0	7.0	104	70	1.42	0.38	13.6	0.58	0.58	76.7	0.14	0.01	0.22	
MR-9A	0.44	14.0	9.0	6.1	136	100	2.11	0.37	13.2	0.62	0.62	67.5	0.02	0.01	0.47	4
MR-12	0.62	45.0	6.0	7.1	136	70	1.43	0.38	14.4	0.61	0.59	68.5	0.08	<0.01	0.16	5
MR-12	0.62	46.0	8.5	7.1	136	65	1.43	0.38	13.6	0.62	0.63	49.1	0.08	<0.01	0.02	6
MR-15	0.72	37.0	5.0	7.2	123	60	1.53	0.35	12.0	0.55	0.57	48.0	<0.01	<0.01	<0.01	
MR-15A	0.72	68.0	9.0	7.0	171	200	3.29	0.53	25.2	0.37	0.32	50.7	0.16	0.35	0.74	4
MR-16	0.76	101.0	12.0	7.3	254	85	1.73	0.49	29.7	0.59	0.53	60.7	0.06	0.01	1.05	7
MR-17	0.76	10.8	5.0	6.8	77	65	1.61	0.33	11.2	0.59	0.58	43.9	0.04	0.01	0.24	8
MR-19	1.05	88.0	15.0	7.0	286	200	4.16	0.59	34.1	1.30	1.14	47.4	0.05	0.04	0.84	9
MR-20	1.10	53.0	17.0	6.6	248	240	5.22	0.58	25.6	1.66	1.59	57.7	0.04	0.02	1.35	
MR-21	1.14	43.0	31.5	6.4	270	350	7.35	0.44	21.6	1.72	3.06	99.8	0.06	0.07	1.92	
MR-37	0.80	13.8	6.0	6.6	98	85	2.10	0.38	8.4	0.75	0.60	70.3	0.02	0.01	0.45	10
MR-37A	0.80	6.0	5.5	6.5	48	32	0.62	0.26	3.6	0.88	0.70	51.1	0.04	<0.01	0.33	4
MR-33	0.97	8.0	11.0	6.4	74	70	1.91	0.35	4.8	0.54	0.59	60.8	0.09	0.01	0.34	
MR-33A	0.97	11.2	5.0	6.2	131	80	2.33	0.52	11.2	0.62	0.56	77.1	0.06	0.01	0.84	4
MR-30	1.05	4.2	5.0	6.4	64	50	1.31	0.34	4.0	0.55	0.56	42.0	0.08	0.01	0.30	
MR-24	1.35	5.8	7.0	6.2	64	22	0.72	0.36	4.0	0.65	0.58	55.6	0.04	0.01	0.16	
MR-23	1.41	7.0	9.0	5.9	60	24	0.80	0.30	3.2	0.58	0.52	41.5	0.14	0.03	0.37	
MR-22	0.56	13.8	4.5	6.7	95	110	3.35	0.12	6.4	0.36	0.15	68.3	0.08	0.01	1.04	

[1] Bowlegs Creek at confluence
[2] Mouth
[3] Isolated pool
[4] Off-channel
[5] Bridge at road
[6] Duplicate
[7] West Fork
[8] East Fork
[9] West Fork (Start Series)
[10] East Fork (Start Series)

SOURCE: STUDY DATA

TABLE 7-26

MONTHLY MASS LOADINGS FOR GILSHEY BRANCH AT STATION WQ-5 AND CONTRIBUTION TO THE PEACE RIVER

Mass Loading Station WQ-5*

Parameter	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Flow (cfs)	3.82	0.23	No Flow	0.23	-	0.15	0.20	0.12	
Ammonia	3.56	0.06	0	0.36	-	0.07	-	0.03	0.68
Nitrate	1.87	0.34	0	0.11	-	0.11	0.25	0.17	0.41
Nitrite	<0.09	<0.006	0	0.006	-	0.007	0.005	<0.003	0.02
Total Nitrogen	11.98	0.78	0	0.75	-	0.71	0.45	0.32	2.14
Total Phosphorus	10.30	0.85	0	1.16	-	0.60	0.34	0.29	1.93
Orthophosphate	9.55	0.82	0	0.95	-	0.56	0.28	0.28	1.78
Fluoride	3.28	0.26	0	0.25	-	0.14	0.41	0.12	0.64
Sulfate	218.1	9.52	0	4.65	-	6.29	25.04	4.00	38.23
Total Suspended Solids	65.5	6.7	0	16.8	-	1.9	1.0	0.6	13.2
Total Dissolved Solids	-	-	0	65.0	-	58.8	100.9	47.0	54.3
Total Organic Carbon	-	-	0	21.90	-	26.9	24.7	9.5	16.6
BOD_5	23.4	0.84	0	1.23	-	0.15	0.39	0.20	3.74

Mass Loading Contribution of Gilshey Branch to the Peace River (percent)

Parameter	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ammonia	-	<0.1	0	<0.1	-	<0.1	-	<0.1
Nitrate	-	<0.1	0	<0.1	-	<0.1	-	<0.1
Nitrite	-	<0.1	0	<0.1	-	<0.1	-	<0.1
Total Nitrogen	-	<0.1	0	<0.1	-	<0.1	-	<0.1
Total Phosphorus	-	<0.1	0	<0.1	-	<0.1	-	<0.1
Orthophosphate	-	<0.1	0	<0.1	-	<0.1	-	<0.1
Fluoride	-	<0.1	0	<0.1	-	<0.1	-	<0.1
Sulfate	-	<0.1	0	<0.1	-	<0.1	-	<0.1
Total Suspended Solids	-	<0.1	0	<0.1	-	<0.1	-	<0.1
Total Dissolved Solids	-	-	0	<0.1	-	<0.1	-	<0.1
Total Organic Carbon	-	-	0	<0.1	-	<0.1	-	<0.1
BOD_5	-	<0.1	0	<0.1	-	<0.1	-	<0.1

No Data Available
* Comparison of data obtained at Station WQ-5 with data obtained at Station WQ-7 (values in kg/day)

SOURCE: STUDY DATA

TABLE 7-27

MONTHLY AND MEAN MASS LOADINGS FOR MARON RUN AT STATION WQ-3 AND CONTRIBUTION TO BOWLEGS CREEK

MASS LOADING STATION WQ-3*

Parameter	May	June	July	Aug	Sept	Oct	Nov	Dec	Mean
Flow (cfs)	0.55	0.10	0.05	0.15	-	0.17	0.10	0.10	
Ammonia	0.20	<0.03	0.02	<0.04	-	0.04	0.05	0.04	0.06
Nitrate	0.27	0.03	0.01	0.04	-	0.13	0.03	0.03	0.08
Nitrite	<0.01	<0.003	<0.001	0.004	-	0.004	0.003	0.003	0.003
Total Nitrogen	1.82	0.23	0.04	0.30	-	0.63	0.08	0.12	0.46
Total Phosphorus	1.32	0.2	0.09	0.27	-	0.36	0.15	0.12	0.36
Orthophosphate	1.32	0.2	0.09	0.23	-	0.33	0.15	0.12	0.35
Fluoride	0.49	0.09	0.05	0.15	-	0.09	0.12	0.08	0.15
Sulfate	16.47	1.75	0.89	5.25	-	5.46	0.38	0.40	4.37
Total Suspended Solids	2.7	1.5	1.3	3.3	-	0.8	1.0	0.5	1.59
Total Dissolved Solids	-	-	32.9	50.3	-	48.7	27.5	23.0	36.5
Total Organic Carbon	-	-	5.4	15.8	-	27.9	9.4	9.6	13.6
BOD_5	1.76	0.23	<0.01	0.63	-	0.88	0.3	0.22	0.58

MASS LOADING CONTRIBUTION OF MARON RUN TO BOWLEGS CREEK (percentage)

Parameter	May	June	July	Aug	Sept	Oct	Nov	Dec
Ammonia	0.1	-	0.7	<3.2	-	0.4	0.5	1.4
Nitrate	0.1	-	<0.1	0.4	-	0.6	<0.1	<0.1
Nitrite	0.2	-	<0.8	3.8	-	0.4	1.0	1.6
Total Nitrogen	0.2	-	0.1	1.5	-	0.8	0.1	0.2
Total Phosphorus	0.6	-	2.9	9.7	-	1.8	2.4	3.4
Orthophosphate	0.7	-	2.6	9.1	-	2.1	2.9	4.0
Fluoride	0.7	-	2.4	9.1	-	0.8	2.3	3.7
Sulfate	0.2	-	0.5	4.5	-	0.6	0.4	0.2
Total Suspended Solids	0.6	-	0.7	1.9	-	1.5	0.9	1.4
Total Dissolved Solids	-	-	1.9	5.5	-	0.8	1.0	1.1
Total Organic Carbon	-	-	0.9	4.1	-	0.8	0.9	1.6
BOD_5	0.2	-	<0.4	2.6	-	0.9	1.3	1.0

- No Data Available

* Comparison of data obtained at Station WQ-3 with data obtained at Station WQ-2 (values in kg/day).

SOURCE: STUDY DATA

TABLE 7-28

FLOOD DISCHARGES AT SELECTED TRIBUTARY CROSS-SECTIONS

Stream	Cross-Section Location (Figure 7-H)	Flood Discharge (cfs) 25-Year	100-Year
Gilshey Branch	A	906	1170
	B	886	1152
	C	1014	1312
	D	950	1260
	E	1236	1598
	F	1674	2144
	G	1626	2135
Gurr Run	H	756	990
	I	870	1140
Stephens Branch	J	898	1163
	K	922	1216
	L	1012	1265
Propps Branch	M	1024	1332
	N	310	400
	O	1485	1935
	P	1567	1969

SOURCE: STUDY DATA

TABLE 7-29

COMPARISON OF EXISTING AND POST RECLAMATION DRAINAGE AREAS
(Conventional Plan)

Waterways Receiving Flow from On-Site Tributaries	Existing Tributary Drainage Area (acres)	Existing Tributary Average Flow (cfs)	Post Reclamation Drainage Area (acres)	Post Reclamation Average Flow (cfs)
Peace River	5,089	4.3	4,817	4.1
Bowlegs Creek	7,061	1.5	6,642	1.4
Drainage to South Parker Branch	4,138	0	4,829	0
Total	16,288	5.8	16,288	5.5

SOURCE: STUDY DATA

TABLE 7-30

COMPARISON OF EXISTING AND POST RECLAMATION DRAINAGE AREAS
(Sand/Clay Cap Plan)

Waterways Receiving Flow from on-site Tributaries	Existing Tributary		Post Reclamation	
	Drainage Area (acres)	Average Flow (cfs)	Drainage Area (acres)	Average Flow (cfs)
Peace River	5,089	4.5	4,817	4.1
Bowlegs Creek	7,061	1.5	6,762	1.4
Drainage to South Parker Branch	4,138	0	4,709	0
TOTAL	16,288	5.8	16,288	5.5

SOURCE: STUDY DATA

TABLE 7-31

COMPARISON OF EXISTING AND POST RECLAMATION DRAINAGE AREAS
(Sand/Clay Mix Plan)

Waterways Receiving Flow from On-Site Tributaries	Existing Tributary		Post Reclamation	
	Drainage Area (acres)	Average Flow (cfs)	Drainage Area (acres)	Average Flow (cfs)
Peace River	5,089	4.3	5,306	4.4
Bowlegs Creek	7,061	1.5	6,273	1.3
Drainage to South Parker Branch	4,138	0	4,709	0
Total	16,288	5.8	16,288	5.7

SOURCE: STUDY DATA

TABLE 7-32

IMPACT OF CLEAR WATER POOL DISCHARGE ON THE PEACE RIVER

Parameter	BASELINE CONDITIONS		MINING CONDITIONS	
	Concentration (mg/l)	Mass Loading (kg/day)	Concentration (mg/l)	Mass Loading (kg/day)
	(Peace River at Station WQ-7)		(Peace River at Station WQ-7)	
Suspended Solids	30	19,747	30	19,747
Total Phosphorus	1.9	1,251	1.9	1,251
Fluoride	1.1	724	1.1	724
	(Existing Mass Loading From Project Site)		(Estimate of Mine Effluent)	
Suspended Solids	--	45.3	13	443
Total Phosphorus	--	3.9	0.75	26
Fluoride	--	1.3	1.8	61
	(Existing Conditions Downstream of Project Site)		(Mine Effluent Mixed In Peace River)	
Suspended Solids	30	19,792	29	20,190
Total Phosphorus	1.9	1,255	1.9	1,277
Fluoride	1.1	725	1.1	785

Calculations are based on the following assumptions:

- Mean Peace River flow rate at the Fort Meade Station between June through September is considered to be 172 MGD.
- Mean constitutent concentrations found in the Peace River at Station WQ-7 (Peace River below Bowlegs Creek confluence) for the months of June through September are: suspended solids 30 mg/l, total phosphorus 1.9 mg/l and fluoride 1.1 mg/l. These values were derived from baseline data collected in the months of June and August 1979.
- Constituent concentrations and flows for all three tributaries flowing directly to the Peace River are similar to those derived for Gilshey Branch (constituent mass load for Gilshey Branch x 3), and that the five major on-site tributaries flowing to Bowlegs Creek are similar enough to those derived for Maron Run to represent the total contribution from the project site to the creek (constitutent mass load for Maron Run x 5).
- Mixing of the mine effluent with the river flow is complete, resulting in a homogeneous mixture .
- Average daily discharge from mine in year having normal rainfall is 9 MGD.
- Estimated mean flow from on-site tributaries between June and September 1979 is 0.77 MGD.

SOURCE: STUDY DATA

TABLE 7-33

COMPARISON OF THE SURFACE WATER QUALITY NEAR THE SOUTH FORT MEADE MINE SITE TO MEASURED VALUES IN CLAY SETTLING AREA DISCHARGES

Constituents(1)	Peace River(2)	Rowlegs Creek(3)	Stephens Branch	Clay Settling Area Supernanatant(4)
pH, (units)	6.6-7.7	4.7-7.2	-	7.8
Specific Conductance, uhos/cm	310	168	101	523
Total Dissolved Solids	163	117	127	348
Calcium	-	-	-	57
Magnesium	-	-	-	22
Sodium	-	-	-	18
Potassium	-	-	-	1.3
Bicarbonate	42	4	7.9	112
Sulfate	56	12.5	8.8	144
Chloride	19.6	14.4	17.3	17
Iron	0.4	0.5	0.4	0.119
Silica	2.3	3.7	4.2	2.5
Fluoride	1.4	0.2	0.4	2.0
Nitrate, as N	1.0	1.5	1.2	1.06
Total Phosphorus	2.5	0.3	0.9	0.09
Radium-226, pCi/l	<0.8	<1.8	2.4	0.67

[1] Units are mg/l unless otherwise noted.

[2] Peace River WQ-7 Station (June, 1979-March, 1980)

[3] Rowlegs Creek WQ-2 Station (June, 1979-March, 1980)

[4] Lamont, et al. 1975. Characterization Studies of Florida Phosphate Slimes.

SOURCE: U.S. EPA. 1979. Development Document for Effluent Limitations Guidelines and Standards, Mineral Mining and Processing Industry, Point Source Category.

8.0 BIOLOGICAL RESOURCES

8.1 THE AFFECTED ENVIRONMENT

8.1.1 INTRODUCTION

8.1.1.1 Regional Setting

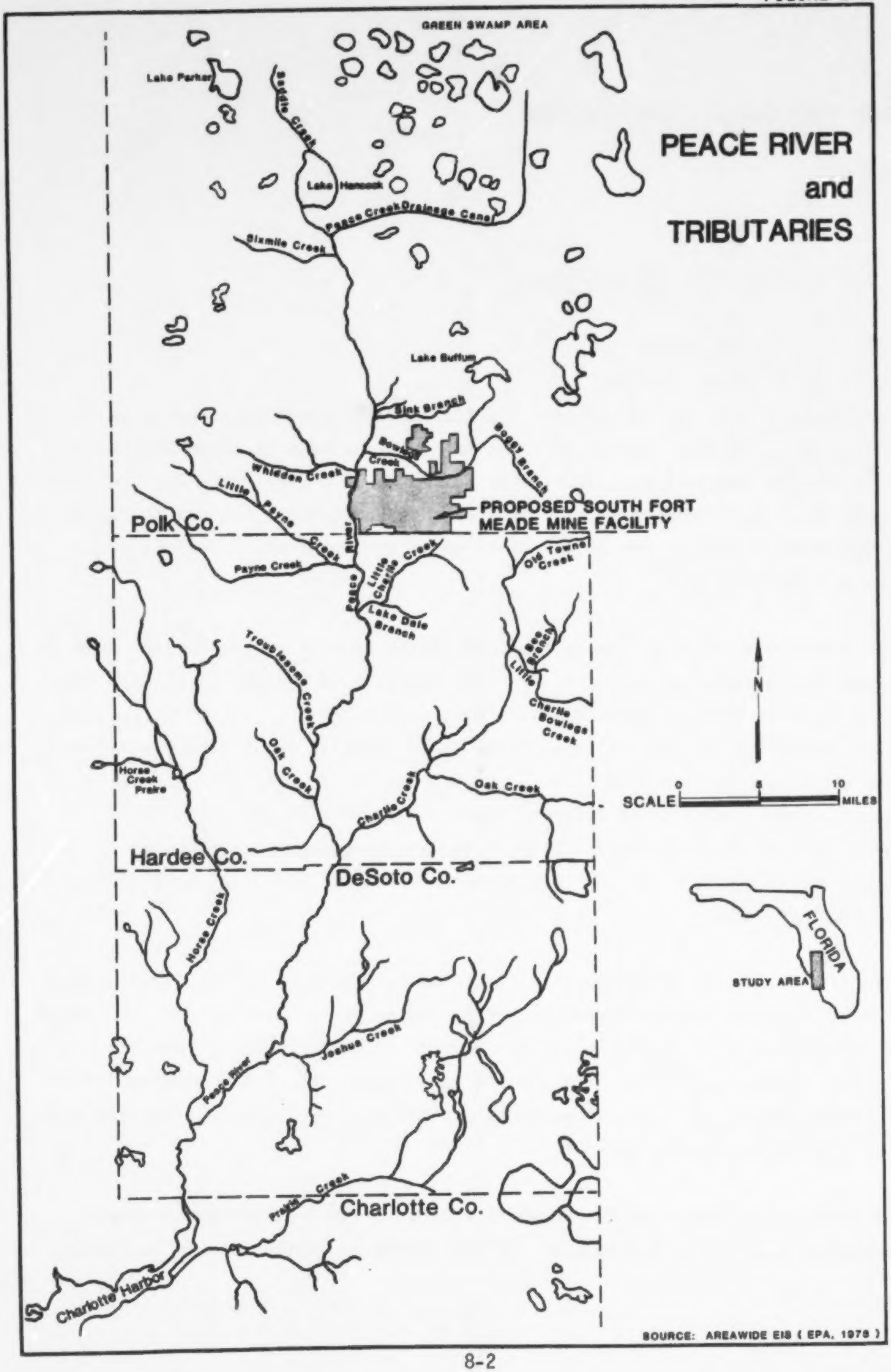
The geological history of central Florida and the geographical position of the peninsula in relation to the main continental land mass of North America have affected the habitats and distribution of fauna in central Florida. The proposed South Fort Meade Mine site is a part of the Central Florida Highlands biogeographic region, one of the seven major biogeographical regions of Florida (Neill, 1957).

The proposed mine site lies in the Polk Upland portion of the Central Highlands physiographic division of Florida (Cooke, 1945 and White, 1970). This area is characterized by north-south elongated ridges, slightly rolling alluvial plains and shallow valleys of the Peace, Alafia, and Hillsborough Rivers. The site lies in the Peace River basin bounded to the west and east by the Lakeland and Winter Haven ridges (Figure 8-A). Most of the Polk Upland is underlain by the Bone Valley geologic formation. Soils are generally acidic, sandy and permeable, and low in clay, organic matter and plant nutrients (Beckenbach, 1973).

The site is in the South Central Climatological Division of the state, characterized by warm, humid summers and mild, dry winters. Over half of the annual precipitation is received in the period June through September (Weather Bureau, 1966), coinciding with the mid and latter part of the growing season for most vegetation. Faunal movement and habitat use patterns correlate with the cycling of wet-dry seasons.

Southern mixed forest is the dominant vegetation type of the southeastern United States. Dominant species include sweetgum, southern magnolia, slash

FIGURE 8-A


PEACE RIVER and TRIBUTARIES

SOURCE: AREAWIDE EIS (EPA, 1978)

pine, and laurel oak. The standard natural vegetation map of Florida (Davis, 1967) displays 17 different vegetation types. Seven of these occur in the central Florida area: pine flatwoods, sand pine scrub forests, longleaf pine and xerophytic oak forests, cypress swamp forests, hardwood swamp forests, upland hardwood forests, and prairie grasslands.

The most extensive vegetation type in central Florida is pine flatwoods. The vegetation of the Peace River valley, however, is predominately hardwood bordered in higher areas by longleaf pine and xerophytic oak, as well as pine flatwoods. The vegetation structure of the Peace River basin changes significantly from its headwaters to its mouth. The headwater region of the upper valley from Lake Hancock to the Fort Meade area is characterized by a wide, easily flooded valley dominated by water-tolerant vegetation. Beginning near Fort Meade, the main channel is deeply incised with very few flood channels. Wetland vegetation is restricted to a narrow channel-side strip without extensive floodplain wetlands. Downstream from Fort Ogden to the river's mouth the wetland zone is continuous and in direct contact with the river system.

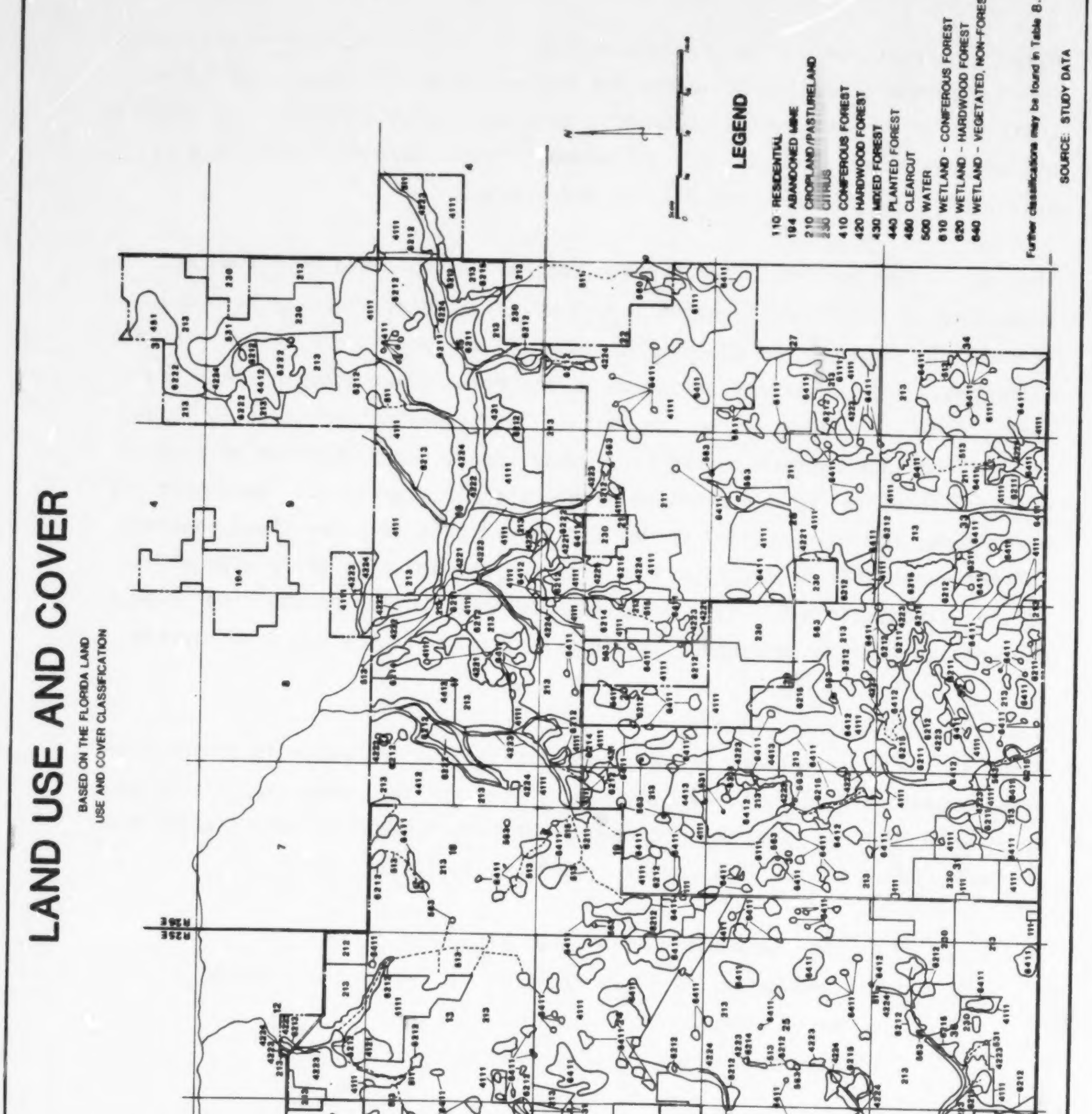
8.1.1.2 Site Description

Based on the Florida Land Use and Cover Classification System in conjunction with an additional classification, thirty land use and cover classification types were identified on the proposed South Fort Meade Mine site (Tables 8-1 and 8-2, Figure 8-B). They may be grouped as follows:

- Land Communities (15 land use types)
- Land-Water Interface Communities (10 land use types)
- Water Communities (3 land use types)
- Developed Areas (2 land use types)

Flora and fauna observed or potentially occurring on the 16,288 acre site were tabulated from field reconnaissance and literature review (Tables 8-3, 8-4, 8-5, 8-6 and 8-7). Developed land (abandoned mines and residential), accounting for 1.3 percent of the total acreage, is excluded from the biological discussions and is presented in the Human Resources section (9.1.2 Land Use).

FIGURE 8-B


LAND USE AND COVER
BASED ON THE FLORIDA LAND USE AND COVER CLASSIFICATION
LEGEND
110 RESIDENTIAL
104 ABANDONED MINE
210 CROPLAND/PASTURELAND
230 CITRUS
410 CONIFEROUS FOREST
420 HARDWOOD FOREST
430 MIXED FOREST
440 PLANTED FOREST
460 CLEARCUT
500 WATER
610 WETLAND - CONIFEROUS FOREST
620 WETLAND - HARDWOOD FOREST
640 WETLAND - VEGETATED, NON-FORESTED
Further classifications may be found in Table 8.1
SOURCE: STUDY DATA
R25E
R26E
T32S
T33S

As a result of human activities the characteristics of native vegetation types have been altered. Pine flatwoods and longleaf pine-turkey oak communities have been logged or replaced by citrus groves. Hardwood forests occur as second-growth stands and often contain pines. Many native grasslands or prairies have been converted to improved pastures. Pasture accounts for 42 percent of the total acreage; an additional 8.5 percent is used for crops and citrus groves. The remaining acreage is divided into forested uplands (35 percent), forested and non-forested wetlands (12 percent), and water communities (<1 percent). Cattle have destroyed much of the native ground cover, the loss of which has resulted in poor structural diversity and wildlife habitat.

Tilling, mowing, burning, drainage and harvesting activities have further disturbed the native habitats on site and partitioned them into small, isolated units. These activities have also limited the development of mature systems, decreasing their value to wildlife. Because of these disturbances, most of the vegetation associations on site cannot be considered representative. For example, some hardwood forests have been destroyed to the extent that they now occur as remnant hammocks on improved pasture with bahia grass replacing the native ground cover. Forested land-water interface communities have undergone logging. Cattle grazing and trampling have altered understory vegetation in both forested and non-forested wetlands. Drainage ditches have altered hydroperiods and have increased susceptibility of these areas to fire.

Water communities on site include the Peace River and Bowlegs Creek, both detrital-based heterotrophic systems (organisms consuming decaying matter). Their tributaries serve primarily as conveyances for excess water accumulating in depressions during precipitation. Most of the man-made and naturally occurring ponds are used for watering cattle and are stagnant and eutrophic.

Wildlife habitat value is generally poor over most of the site because of the small size, discontinuity and disturbed nature of the vegetation types. Present land use is favorable to the growth of ruderal vegetation, and consequently much of the wildlife are generalistic species.

8.1.2 LAND COMMUNITIES

Seven major types of land communities occupy 88 percent of the total acreage of the proposed South Fort Meade Mine site. These communities are coniferous forest, hardwood forest, mixed forest, planted forest, clearcuts, cropland/pasture and citrus. They are discussed in the following sections, first in terms of their ecological/functional characteristics and then more specifically in terms of their flora and fauna.

Agriculture is the predominant land use on site, accounting for 51 percent (8,282 acres) of the total acreage. Cropland/pasture occupies the majority of this land (47 percent of the site or 7,716 acres). Coniferous, hardwood, and mixed forests (33 percent of the site or 5,342 acres) are concentrated primarily in narrow strips along streams and along the property boundary, whereas the agricultural communities occupy the interior portion of the site. The forested areas have undergone extensive logging, and cattle grazing and trampling have altered natural understory vegetation. Erosion and runoff have increased with reduction in ground cover. Ditching to facilitate drainage has resulted in the disruption of species composition and diversity, biomass, productivity, nutrient availability, and structural integrity of the communities. Alteration of vegetation and other ecological characteristics has reduced the functional values of these systems and diminished their value for wildlife or recreational use.

8.1.2.1 Coniferous Forests

8.1.2.1.1 Ecological/Functional Description

On the site, coniferous forests are represented by two distinct elements: cutover pine-palmetto flatwoods and cutover longleaf pine-sandhill oak. Flatwoods represent the most common and widespread vegetation type in Florida and typically occur on shallow, sandy soils overlying mineral or organic hardpans. These hardpans restrict downward movement of water and dissolved nutrients, resulting in poor drainage and seasonally saturated soil conditions. Longleaf pine-sandhill oak associations usually occur on xeric, sandy soils at slightly higher elevations than flatwoods. In both communities, periodic fires control species composition and release mineral nutrients to the soil. Burning is a common practice in the flatwoods on site for improving cattle grazing and timber production.

Both coniferous communities typically exhibit moderate plant diversity and high wildlife diversity but low biomass, gross productivity and nutrient availability. On the Mobil site, however, both communities have been altered resulting in reduced biomass and local invasion by hardwoods and low floral and faunal diversity. Decreased plant diversity and biomass reduce the nutrient recycling function of the community.

8.1.2.1.2 Flora

Cutover pine-palmetto flatwoods occupy 3,389 acres or 21 percent of the site. The canopies of the cutover pine flatwoods communities are open, with ground cover approaching 100 percent on most sites. Important species include longleaf pine, saw palmetto, gallberry, three-awn grasses, panic grass, love grass and scrub live oak (Table 8-3).

A remnant stand of cutover longleaf pine-sandhill oaks (23 acres or 0.14 percent of the site) occurs in the north central part of the site (Figure 8-B). The plants found on this stand are adapted to high light intensity, xeric soils and low nutrient availability. Typical canopy species include longleaf pine, scrub live oak, bluejack oak and persimmon. Common understory species include panic grass, dropseeds, saw palmetto, dogfennel, New Jersey tea, gopher apple, laurel oak and scrub live oak (Table 8-3).

8.1.2.1.3 Fauna

The existing vegetation favors the presence of cotton rats, cottontail rabbits, mourning doves and bobwhites. Some of the more common inhabitants include the nine-banded armadillo, feral hog, white-tailed deer, opossum, pine warbler, rufous-sided towhee, red-tailed hawk, great horned owl, pine woods treefrog, oak toad, eastern diamondback rattlesnake, black racer and box turtle.

8.1.2.2 Hardwood Forests

8.1.2.2.1 Ecological/Functional Description

On the proposed mine site, four subtypes of the hardwood forest association exist as components of either xeric or mesic hammocks. Despite considerable intergradation between types, they often are distinguishable by elevation and soil moisture. The xeric hammock is dominated by live oak with little to no midstory and sparse ground cover; it occurs on well-drained sandy soils at higher elevations. On the Mobil site, the xeric hammock type is represented by live oak with mixed understory and live oak with bahia understory associations. Plant and animal diversity (typically low in these communities), biomass, productivity and nutrient availability are reduced by cattle usage.

Mesic hammocks occur at lower elevations on soils with high soil moisture and organic content. Oaks and southern magnolia are common canopy species. The upland mesic association on the Mobil property is a transition between the xeric live oak association and bottomland hardwoods. The level of plant and animal diversity and productivity is also reduced in these associations.

8.1.2.2.2 Flora

Four subtypes of the hardwood forest community are recognized on the site: live oak with mixed understory, live oak with bahia understory, upland mesic, and transition mesic or bottomland hardwood (Figure 8-B). The total cover by hardwood forest is 1,804 acres or 11 percent of the total site (Table 8-2).

The live oak with mixed understory association occurs on uplands where cattle grazing has not eliminated the native understory. The soils range from xeric to mesic. Most of the units are small, totalling 109 acres and representing about 6 percent of the hardwood forest acreage, less than 1 percent of the total site. Percent canopy closure is variable, and all stands are clearly dominated by live oak. Understory species include yaupon, tallowwood, dwarf cabbage palm, saw palmetto, persimmon, pawpaw, prickly pear and hawthorne.

Stands of live oak with bahia understory occur as remnant oak hammocks on improved pasture. Although the trees are scattered and permit good light penetration to the understory, grazing activities have eliminated most of the understory and ground cover. Where grazing is less severe, pasture grasses such as bahia, love grass and panic grass are dominant. Weed species such as sawbriers, wild grapes, elephant's foot and yellow jessamine also occur (Table 8-3). The live oak-bahia understory association occupies 118 acres, 7 percent of the hardwood forests and less than 1 percent of the site (Table 8-2).

Upland mesic hardwood forest is dominated by a mixture of hardwoods. The woody understory and ground cover vary from dense to nearly sparse, depending on stand maturity and local soil moisture and fertility. This association represents a second-growth forest dominated by early successional species on sites where climax oak hammocks have been disturbed. Canopy closure and species composition of the upland mesic hardwood forest are highly variable. Dominant canopy species include live oak, laurel oak, water oak, sweetgum and southern magnolia. The woody understory and ground cover include American beautyberry, greenbrier, Spanish moss, blackberry and sedges (Table 8-3). The upland mesic forest association occupies 660 acres, 37 percent of the total hardwoods and 4 percent of the total site (Table 8-2).

The transition mesic or bottomland hardwood forest association occurs downslope of the upland mesic forest along the moisture gradient from upland to wetland. Species encountered include a mixture of upland and wetland types such as laurel oak, red maple, black gum and sweetgum. Gallberry, soft rush and St. John's wort are locally abundant. This transition type covers 917 acres or 5.6 percent of the site.

8.1.2.2.3 Fauna

Animals commonly associated with upland hardwoods are the eastern mole, southern flying squirrel, gray squirrel, cotton mouse, feral hog, barred owl, pileated woodpecker, great crested flycatcher, green anole, southern toad and oak toad. On mesic sites the green treefrog, southern leopard frog, red-bellied woodpecker and raccoon are common. Hardwoods with a bahia grass understory have less vegetation diversity and, therefore, a reduced animal diversity.

8.1.2.3 Mixed Forests

8.1.2.3.1 Ecological/Functional Description

Vegetation associations where neither hardwoods nor coniferous species predominate are classified as mixed forests. This association type is a result of either fire suppression in pine communities resulting in subsequent hardwood invasion, or logging or burning in a hardwood forest followed by an early successional community. Most of the mixed forest communities on the Mobil site occupy well-drained sandy soils along the valley walls of the Peace River and Bowlegs Creek, suggesting secondary invasion of logged hardwood forests. On the interior of the site, mixed forests have developed as a result of fire suppression or ditching to improve drainage in natural pinelands. Plant and animal diversity, biomass, productivity and nutrient availability in mixed forests range from low to moderate. On the Mobil site, cattle usage and ditching have altered these systems and reduced their value as wildlife, aesthetic and recreational resources.

8.1.2.3.2 Flora

Several stands of the mixed forest cover type occupy a total of 126 acres or 1 percent of the site (Figure 8-B and Table 8-2). The canopy is a mixture of conifers and hardwoods where neither type is clearly dominant. Tree species include sweetgum, live oak, laurel oak, water oak, slash pine and longleaf pine. Woody understory and herbs are represented by sawbriers, caesarweed, muscadine, waxmyrtle, sage, saw palmetto, lantana and American beautybush (Table 8-3).

8.1.2.3.3 Fauna

Mixed hardwood cover types are inhabited by fauna associated with both longleaf pine and upland mesic hardwoods (Tables 8-4, 8-5, 8-6 and 8-7). These include spadefoot toad, oak toad, black racer, southeastern pocket gopher, gray squirrel, blue jay, rufous-sided towhee, red-shouldered hawk and bobwhite. Wildlife habitat quality is poor because of the small size, discontinuity and disturbed nature of the stands.

8.1.2.4 Planted Forests

8.1.2.4.1 Ecological/Functional Description

Plantation pines have been established on the site as row plantings in areas that have been burned, harrowed and cleared of vegetation. Plantations without ground cover or with bahia understory have low plant and animal diversities. Planted pine plantations with flatwoods understory have moderate plant diversity and low to moderate animal diversity. Biomass and productivity vary, and nutrient availability is low.

8.1.2.4.2 Flora

Three types of planted slash pine forests occur on the proposed mine site, distinguished by their understory composition (Table 8-1). Together they occupy 340 acres or approximately 2 percent of the site (Table 8-2). The pine plantation without ground cover occurs as a single stand of 17 acres in the south central part of the property. Stand density is high (908 trees per acre) and canopy closure is complete. Dense shading and heavy litter accumulation have excluded ground cover species.

Two stands of planted pine with a bahia grass understory occur in the north central and northeast parts of the site. The trees in these stands have been thinned to improve timber production, resulting in open canopies and sufficient light penetration to support pasture grasses. Both stands are heavily grazed and occupy 204 acres, approximately 60 percent of the planted pine forest on the site.

Planted pine with flatwoods understory occurs as a 118 acre stand near the center of the site. This stand is similar in species composition to flatwoods communities characteristic of central Florida. The understory is a mixture of shrubs and herbs including saw palmetto, gallberry, fetterbush, dwarf huckleberry, shining sumac, bracken fern, broomsedge, polygala, poison ivy and greenbrier (Table 8-3).

8.1.2.4.3 Fauna

During early stages of growth, pine plantations resemble old-field vegetation. Closure of the canopy and/or controlled burning result in reduced floral diversity and consequently a low faunal diversity. Species commonly found in all three types of plantations are the southern toad, garter snake, black racer, cotton rat, cottontail, nine-banded armadillo, house mouse, eastern diamondback rattlesnake, red-shouldered hawk, bobwhite, blue jay and pine warbler.

8.1.2.5 Clearcuts

8.1.2.5.1 Ecological/Functional Description

The clearcut bayhead on site occupies a shallow depression which used to be a seepage outcrop zone. The original condition was the result of lateral water table percolation from the adjacent sandy ridge which is now covered by improved pasture and orange groves (Figure 8-B). Local depression of the water table from pumping for grove irrigation and stock watering may have produced the present dry condition. All ecological characteristics are extremely low in value.

8.1.2.5.2 Flora

The cleared bayhead occupies 39 acres in the northeast corner of the site (Figure 8-B, Table 8-2). All vegetation has been stripped, leaving bare peat soil with no regrowth of woody or herbaceous vegetation.

8.1.2.5.3 Fauna

The clearcut provides poor wildlife habitat due to extensive disturbance. Fauna in adjacent habitats may use the clearcut as it becomes revegetated. Animals which may use such early successional habitats include the southern toad, ground skink, garter snake, mourning dove, bobwhite, eastern mole, nine-banded armadillo, cotton mouse and striped skunk.

8.1.2.6 Cropland/Pasture

8.1.2.6.1 Ecological/Functional Description

Agriculture is the predominant land use on the Mobil site, accounting for 7,716 acres or 47 percent of the site. Grasses, the dominant vegetation cover, have replaced much of the native vegetation and are managed to increase productivity. Pasture provides erosion and runoff control as a result of the soil-binding root systems. Plant and animal diversity and biomass are generally low. Nutrient availability depends on fertilization practices.

8.1.2.6.2 Flora

The most important single cover type on the tract is improved pasture, accounting for 6,876 acres or 42 percent of the site (Figure 8-B). The pasture supports a variety of introduced and native grasses such as bahia, bermuda, smutgrass, love grasses, sandspur, panic grasses and carpet grass (Table 8-3). Row crops are grown on several large commercial farms near the southeast corner of the site (Figure 8-B). Crops include cucumbers, squash, corn, peppers and tomatoes. Row crops cover 810 acres or about 10 percent of the total cropland/pasture. A single 30-acre tract near the north central property boundary is in field crops.

8.1.2.6.3 Fauna

Few animals use either row crops, field crops or improved pastures as nesting or breeding habitats (Tables 8-4, 8-5, 8-6, and 8-7). Exceptions are the burrowing owl, eastern cottontail rabbit and nine-banded armadillo. Species such as the striped skunk and red fox forage in these areas. The broad expanses of agricultural land bordering most major habitats are used by transient fauna such as the bobwhite, meadowlark, burrowing owl, cattle egret, black racer, pocket gopher, eastern cottontail, nine-banded armadillo and yellow bat.

8.1.2.7 Citrus

8.1.2.7.1 Ecological/Functional Description

Some suitable citrus soils occur on the site along the Peace River and Bowlegs Creek. Citrus groves occupy 566 acres or 3 percent of the site. Most groves on the site are not at peak production due to age, ground cover or management practices. Because citrus is an intensively managed cover type, plant diversity is low; animal diversity varies with fruiting. Nutrient availability varies depending on management practices.

8.1.2.7.2 Flora

Citrus groves are located along Mt. Pisgah Road and the northeast corner of the site (Figure 8-B). Rigorous pest management practices exclude most competing vegetation species. Weed species seasonally invading the groves include caesarweed, pigweed, ragweeds, carpet grass, sicklepod, drymaria and morning glory (Table 8-3).

8.1.2.7.3 Fauna

Citrus groves provide perching and cover habitat for birds. The majority of the species associated with citrus groves do not use the habitat as nesting or foraging areas (Tables 8-4, 8-5, 8-6, and 8-7). When groves are abandoned, neglected, or maintained with an early successional ground cover, the habitat is more valuable for use as breeding sites. Animals commonly seen in the groves are the southern toad, garter snake, black racer, cattle egret, loggerhead shrike, bobwhite, pocket gopher, cotton rat, armadillo and cottontail.

8.1.3 LAND-WATER INTERFACE COMMUNITIES

The three land-water interface communities on the proposed South Fort Meade Mine site occupy approximately 2,054 acres or 13 percent of the site. Wetland coniferous forest accounts for 78 acres (0.5 percent of the site and 4 percent of the wetland acreage on site). Wetland hardwood forest accounts for 936 acres of the site or 45 percent of the wetland acreage. Wetland vegetated non-forested associations account for 1,040 acres or 51 percent of the wetland acreage. Forested wetland associations on site are scattered and occur primarily along streams. Vegetated, non-forested wetlands occur as small, isolated units on the site interior. Deeper freshwater marshes occupy headwater positions of streams in the south central portion of the property.

These forested wetland areas have undergone logging and burning, and cattle grazing and trampling have altered the understory vegetation. Drainage ditches have altered hydroperiods and increased susceptibility of these areas to fire. Plant and animal diversities are thus reduced, as are biomass, productivity, species composition and abundance, and nutrient availability. Wildlife habitat values are poor except in large stands where cattle have been excluded. Storm water retention and water purification functions of these wetlands have been diminished as a result of the understory and ground cover alterations. In short, man's influences have altered vegetation diversity of the wetland systems, changing their ecological and functional characteristics and reducing aesthetic and recreational values.

8.1.3.1 Wetland Coniferous Forest

8.1.3.1.1 Ecological/Functional Description

These communities occur as domes exhibiting zoned internal structure and develop in shallow plateau depressions where rainfall is the principal source of water. They contain acidic, poorly buffered waters with minimal groundwater influence. Complete drying is common during the dry season and flooding results from wet season rainfall. Cypress communities are considered subclimax due to peat accumulation, resulting in succession to hydric hardwoods.

Cypress communities are most valuable where perennial pools are maintained and the canopy is open. Shallow domes offer poor habitat because of their limited water storage capacity. They exhibit low species diversity, closed canopy, and minimal accumulation of organic material.

Wetland coniferous forests occurring on the South Fort Meade Mine site are the shallow cypress pond type. Their value is relatively poor because of shallow depth, poor retention of nutrients and limited access to a nutrient supply. Because they are small and offer little structural diversity, they provide limited wildlife habitat.

8.1.3.1.2 Flora

Isolated cypress communities cover approximately 78 acres of the interior of the site (Table 8-1, Figure 8-B), representing less than 1 percent of the site and approximately 4 percent of the total wetland acreage (Table 8-2). These stands occupy small local depressions on poorly drained level ground, frequently in association with pine-palmetto flatwoods. Canopy species of the ponds or domes include cypress, laurel oak, black gum and red maple. Understory and ground cover are highly variable and dependent on such factors as depth and hydroperiod. Species with a high frequency of occurrence on site include rushes, carpet grass, pickerelweed and smartweed (Table 8-3).

8.1.3.1.3 Fauna

The large cypress dome on the east side of the property provides refuge for animals from adjacent habitats. Relative to other habitats on the site, the cypress domes are least used by birds but contain an even distribution of vetebrate groups (Tables 8-4, 8-5, 8-6, and 8-7). Some of the more commonly observed wildlife in the cypress domes are the green treefrog, squirrel treefrog, southern leopard frog, box turtle, ground skink, banded water snake, mud snake, green heron, little blue heron, white-eyed vireo, barred owl, opossum, gray squirrel and raccoon. Additionally, the waters are populated by golden topminnow, eastern mosquitofish and least killifish.

8.1.3.2 Wetland-Hardwood Forest

8.1.3.2.1 Ecological/Functional Description

Bayheads and mixed hardwood swamps are the major associations of the wetland-hardwood forests. Both are considered climax communities, although they will succeed to a hammock situation if drying conditions exist in mixed hardwood swamps or in the absence of peat accumulation in bayheads. The mixed hardwood swamp is believed to represent the wet phase of the southern mixed hardwood forest association.

On the proposed mine site, seven types of these two associations occur. Bayhead communities exist along tributaries where bed erosion has cut below the permanent water table of highly permeable sandy soils. These stands occur on sloping ground which drains to streams only during extreme precipitation. Flow is usually one-way due to the physical isolation of these communities from the incised stream channels. Although bayheads provide limited flood protection, sediment filtering and water purification, they do provide excess water storage, and the leaf litter serves as a nutrient source. The small size and degraded nature of the communities reduce wildlife habitat value.

Mixed hardwood swamp associations on the site appear to represent second-growth stands in previously burned or logged bayheads, as the vegetation usually occupies peaty hummocks separated by wetted areas. Such hummocks often originate where fires burn away the peat between large trees during severe droughts. Stumps from previous growth and debris accumulation tend to perpetuate localized high points. When wet weather returns, the depressions in which these stands occur are flooded. Functional values and characteristics of these associations are similar to those described for the bayhead communities on site.

8.1.3.2.2 Flora

The wetland-hardwood forest association includes seven types of subcommunities (Table 8-1, Figure 8-B). These stands total 936 acres, 6 percent of the mine site or 46 percent of the wetland acreage (Table 8-2).

On the site, gum-maple forests have open canopies dominated by black gum and red maple. The canopy may also contain sweetgum, water oak, dahoon and sweetbay. The soils are peat or muck, and most vegetation is restricted to the hummocks. During the wet season, the forests are flooded between the hummocks. Gum-maple associations represent a secondary stage in swamp succession and are indicators of recent disturbances (burning or logging) in later successional communities such as bayheads. Gum-maple associations cover about 185 acres of the site or 20 percent of the wetland-hardwood forest association.

Bayheads represent a late stage in flatwoods pond community succession, replacing cypress and gum-maple swamps as peat deposits fill in the original depressions. On the proposed mine site there is little open water present in undisturbed stands, and canopy closure is complete. Dominant canopy species are sweetbay, laurel oak and water oak, and occasionally sweetgum and red maple. Species found in the understory include cinnamon fern, royal fern, Virginia willow and swamp azalea (Tables 8-3). Bayheads account for 46 percent of the wetland-hardwood forest (Table 8-2).

Bay strands occur on water table outcrops where soil saturation is chronic. On the Mobil site, these strands occur as long, narrow wetland strips at the base of porous sand ridges and in seepage zones along stream channels. Species composition on site is similar to the bayhead association. Bay strands cover 23 acres, representing only 2 percent of the wetland-hardwood forest (Table 8-2).

Myrtle thickets occupy 21 acres or 2 percent of the wetland hardwood forest. These small stands occur along non-forested stream and pond margins where the water table is near the soil surface. On the site, waxmyrtle dominates with common associates including bluestem, blackberry, rushes and grasses.

Mixed hardwood swamps occupy 198 acres or 21 percent of the wetland-hardwood forest. These swamps are dominated by a diverse mixture of tree species including red maple, sweetbay, black gum, sweetgum, water oak, blue beech, southern magnolia, Florida elm and dahoon. The understory and ground cover are similar to those found in bayheads.

The disturbed gum-maple swamp and disturbed bayheads occupy 8 and 84 acres, respectively. Both are similar to their undisturbed counterparts except that fire or wind damage has created canopy openings permitting local invasion by adventive species. These invading species are more characteristic of upland vegetation associations and will be eliminated as the disturbed communities recover.

8.1.3.3.3 Fauna

Wetland-hardwood forests on the site have a reduced habitat quality and faunal diversity. Wildlife species commonly observed in these wetlands are the greenhouse frog, oak toad, little grass frog, southern leopard frog, box turtle, striped swamp snake, ribbon snake, black racer, cottonmouth, pygmy rattlesnake, white-eyed vireo, red-shouldered hawk, barred owl, blue jay, opossum, nine-banded armadillo, marsh rabbit, cotton mouse, raccoon, river otter, bobcat and feral hog.

8.1.3.3 Wetland-Vegetated, Non-Forested

8.1.3.3.1 Ecological/Functional Description

Non-forested vegetated wetlands are represented on the site by shallow and deep water marshes. Shallow marshes, or wet prairies, are seasonally flooded with distinct wet/dry periods. Sand or muck soils support a mixture of emergent grasses, sedges, rushes and herbs. Deep water marshes are characterized by floating leaf aquatic species and generally develop on the margins of ponds, lakes, open marshlands and sloughs. The deep marsh's hydroperiod usually exhibits standing water in some areas year-round.

Both shallow (less than 3 feet in depth) and deep (over 3 feet in depth) marshes occur on the proposed mine site. The shallow marsh systems occur as numerous, small isolated depressions in the interior of the site. During prolonged rainfall, these depressions overflow and eventually drain into streams. Deep marshes occur as headwater collection systems for streams in the south central part of the site. Both marsh associations have been degraded by cattle grazing and trampling. Biomass and other ecological characteristics such as plant and animal diversity have been reduced or altered.

8.1.3.3.2 Flora

Wetland-vegetated non-forested associations comprise 1,040 acres and represent 51 percent of the land-water interface communities. Shallow marshes totalling 883 acres (85 percent of the wetland-vegetated non-forested cover class) in the interior of the site are depression features wetted by rainfall, runoff and seasonally high water tables. Deep marshes have structure and vegetation similar to the shallow marshes but occupy lowland areas along stream systems. These deep marshes occupy 157 acres or 15 percent of the wetland-vegetated non-forested cover class.

Although these communities are dominated by herbs, occasional trees such as Carolina willow, buttonbush and waxmyrtle are present near their margins. Important herbs present include Virginia chain fern, pickerelweed, sawgrass and primrose willow (Tables 8-3).

8.1.3.3.3 Fauna

The marshes are occasionally used as foraging areas by herons, egrets and other wading birds, and as breeding sites by red-winged blackbirds and pied-billed grebes. The American alligator, Florida softshell, banded water snake, king snake, cottonmouth, two-toed amphiuma, greater siren, chorus frog and pig frog are common reptiles and amphibians found in these marshes. The amphibians use the marshes for breeding sites. The rice rat, raccoon and marsh rabbit are common mammals of both marsh systems. Introduction of cattle and construction of drainage canals have lowered the quality of this habitat and created a stressed, more ephemeral water regime. Few wading birds were actually observed in the marshes on site. The eastern mosquitofish, least killifish and Everglades pygmy sunfish were found in the deep marsh systems.

8.1.4 WATER COMMUNITIES

Both lentic (standing) and lotic (flowing) water communities occur on the proposed South Fort Meade Mine site. Lentic communities occupy less than 0.1 percent of the site and include man-made ponds and naturally occurring, unvegetated ponds. These ponds are eutrophic, supporting numerous algal blooms and exhibiting low plant and animal diversities. The primary function of the onsite ponds is water storage for cattle.

Lotic communities on the site include the Peace River, Bowlegs Creek and several small intermittent tributaries. Lotic systems on and adjacent to the site are detrital-based heterotrophic systems and are typical of aquatic communities in the region. Adjacent to the site, the Peace River exhibits a steep gradient with increased stream flow and unstable substrate resulting in lowered floral and faunal diversity. Water quality has been degraded as a result of agricultural, industrial, and urban waste input. Bowlegs Creek provides drainage of surface runoff from much of the site and has been altered by channelization and previous impoundment. On-site tributaries are intermittent with average annual flows less than 5 cfs at the property boundary. They are limited in productivity and plant and animal diversity, and their primary benefit to the site is conveyance of excess water off the property. The streams function in a limited manner as nutrient sources and biological reservoirs for colonization of downstream areas. Aesthetic and recreational values of the lotic communities are low with the exception of the Peace River and Bowlegs Creek where values are moderate adjacent to the property.

8.1.4.1 Peace River

8.1.4.1.1 Ecological/Functional Description

The Peace River originates in northern Polk County from a series of lake systems in the Green Swamp (Figure 8-A). It flows for approximately 105 miles through Polk, Hardee, and Desoto Counties, with its terminus at Charlotte Harbor in Charlotte County. Under average flow conditions, stream width varies from 60 to 200 feet, and depth varies from 1.5 to 10 feet. Stream flow varies considerably with high flows occurring from late summer to early fall, and low flows occurring in the spring.

The structure and function of the Peace River basin change significantly from headwaters to terminus. The headwater region in the upper basin is characterized by a wide, easily flooded valley which extends from Lake Hancock downstream to just north of Fort Meade (Figure 8-C). The anastomosing (branching) channel overflows the low banks periodically, and valley vegetation is dominated by water-tolerant species.

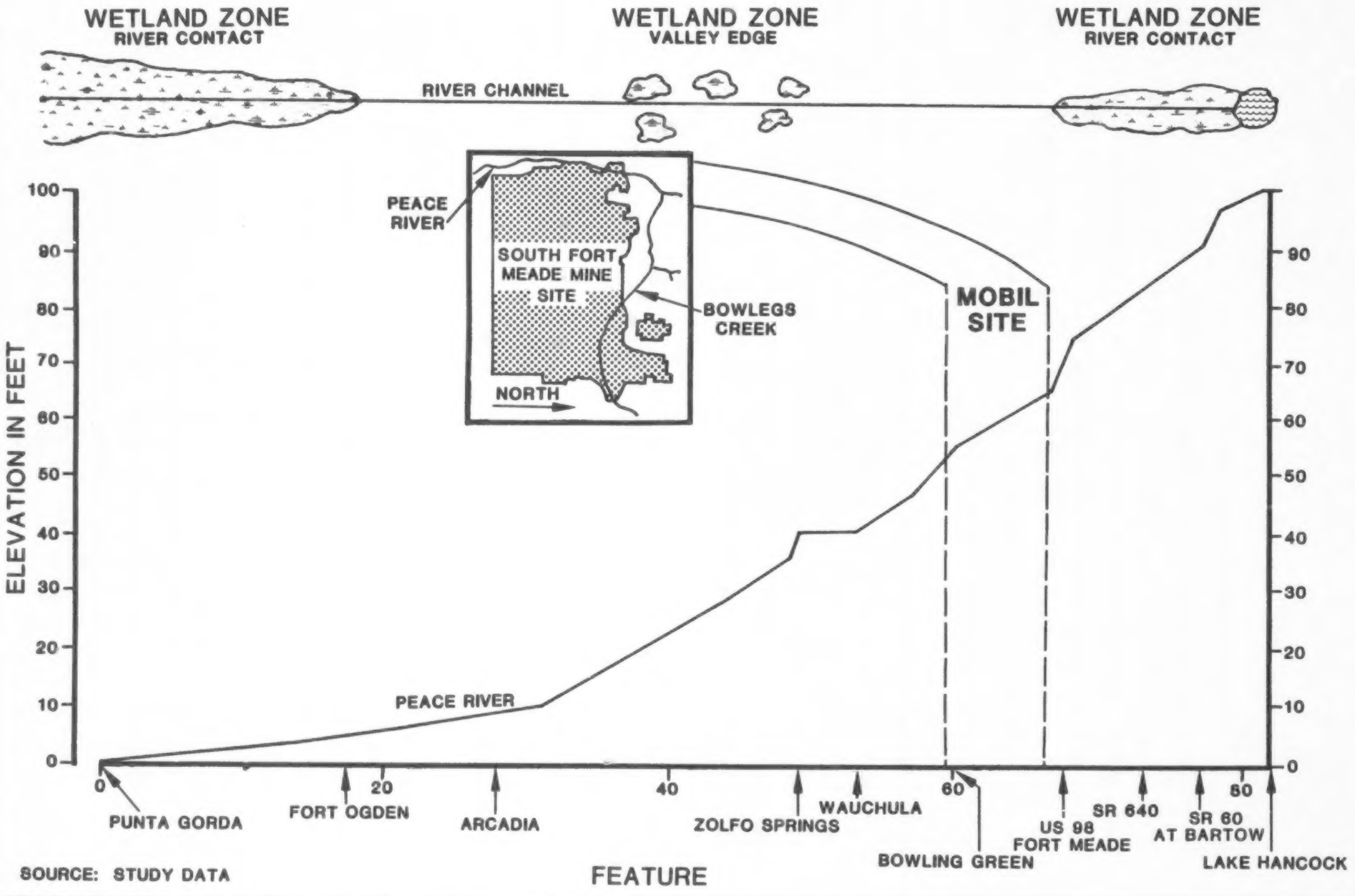
Beginning in the vicinity of Fort Meade, the main channel is deeply incised with very few flood channels. The channel bottom is formed by the exposed Bone Valley and Hawthorne formations; this characteristic continues downstream to Zolfo Springs (Lanquist, 1953). The channel bottom in the rest of the valley is composed of Pleistocene sands overlying these strata, accompanied by clay wastes and/or organic material.

Downstream from Fort Meade, the gradient of the exposed formation results in increased water velocity, and wetland vegetation is restricted to a narrow channel-side strip without extensive floodplain wetlands (Figure 8-C). Extensive wetlands recur in the vicinity of Fort Ogden and continue downstream to the mouth.

Upstream from Fort Meade, wetlands are connected to the Peace River and serve as reservoirs of detrital material. During high flow periods, these easily flooded wetlands are flushed and materials are swept downstream. Color chara teristics and organic carbon content exhibit a direct relationship to stream flow, indicating the flushing of these adjacent wetland systems.

FIGURE 8-C

PEACE RIVER PROFILE AND WETLAND ZONES



SOURCE: STUDY DATA

On the site, wetlands are either isolated from the river or limited to a narrow strip bordering the river. Flood flows generally are contained within the bank; therefore, detrital input is limited. Tributary contributions to the river are also limited (Section 7.1.4.3 On-Site Tributaries).

The steep channel gradient in the Peace River adjacent to the site results in stream scour and unstable substrates, thus limiting colonization and community stability of flora and fauna. Aquatic macrophyte abundance and diversity are low due to poor light penetration and high flows.

8.1.4.1.2 Flora

Algae: The Peace River is generally heterotrophic, but phytoplankton and the attached algal component of the periphyton community contribute to the primary productivity of the river (Table 8-8). Algae, both planktonic (associated with the water column) and attached, serve as indicators of water quality (EPA, 1973 and 1977). Algal data collected at the Polk-Hardee County Line at State Route 644 (PNS #25.02.008) by the FDER indicate that the algal community is dominated by coccoid green algae in the winter and pennate diatoms in the fall. None of the reports indicate any evidence of nuisance algal growths. However, Lanquist (1953) reported high growths in the upper Peace River of Oscillatoria, a bluegreen algae often associated with taste and odor problems (EPA, 1977). Ware (1969) reported a bloom of Rhizoclonium, a green algae generally indicative of relatively clean water, in the upper Peace River (EPA, 1977). The algal community of the Peace River is qualitatively diverse but quantitatively low due to natural color and turbidity which reduce light penetration. Phosphate and nitrogen levels are more than sufficient to support the algal population, and it is highly unlikely that carbon is limited, given the alkalinity and TOC levels in the Peace River.

Aquatic Macrophytes: Distribution and extent of the aquatic macrophyte community are primarily a function of temperature, light penetration and stream flow. Within the lotic ecosystem these plants function to provide habitat, contribute organic material, and stabilize stream banks.

The most abundant aquatic macrophytes of the Peace River basin are pondweed, smartweed, pennywort, widgeon grass, alligator weed, water hyacinth, shoal grass and bulrush (Table 8-9). Eelgrass, southern naiad, alligator weed, paragrass, hydrilla and cow lily are the more common aquatic macrophytes occurring in the Peace River adjacent to the site. Within the portion of the Peace River bounded by the project site, the relative abundance of these aquatic species is highly variable, depending on light and stream velocity.

8.1.4.1.3 Fauna

Macroinvertebrates: Macroinvertebrates play a significant role in the decomposition of detrital material and serve as the basic food resource for several groups of aquatic organisms. They also are indicators of water quality and stresses on the aquatic system.

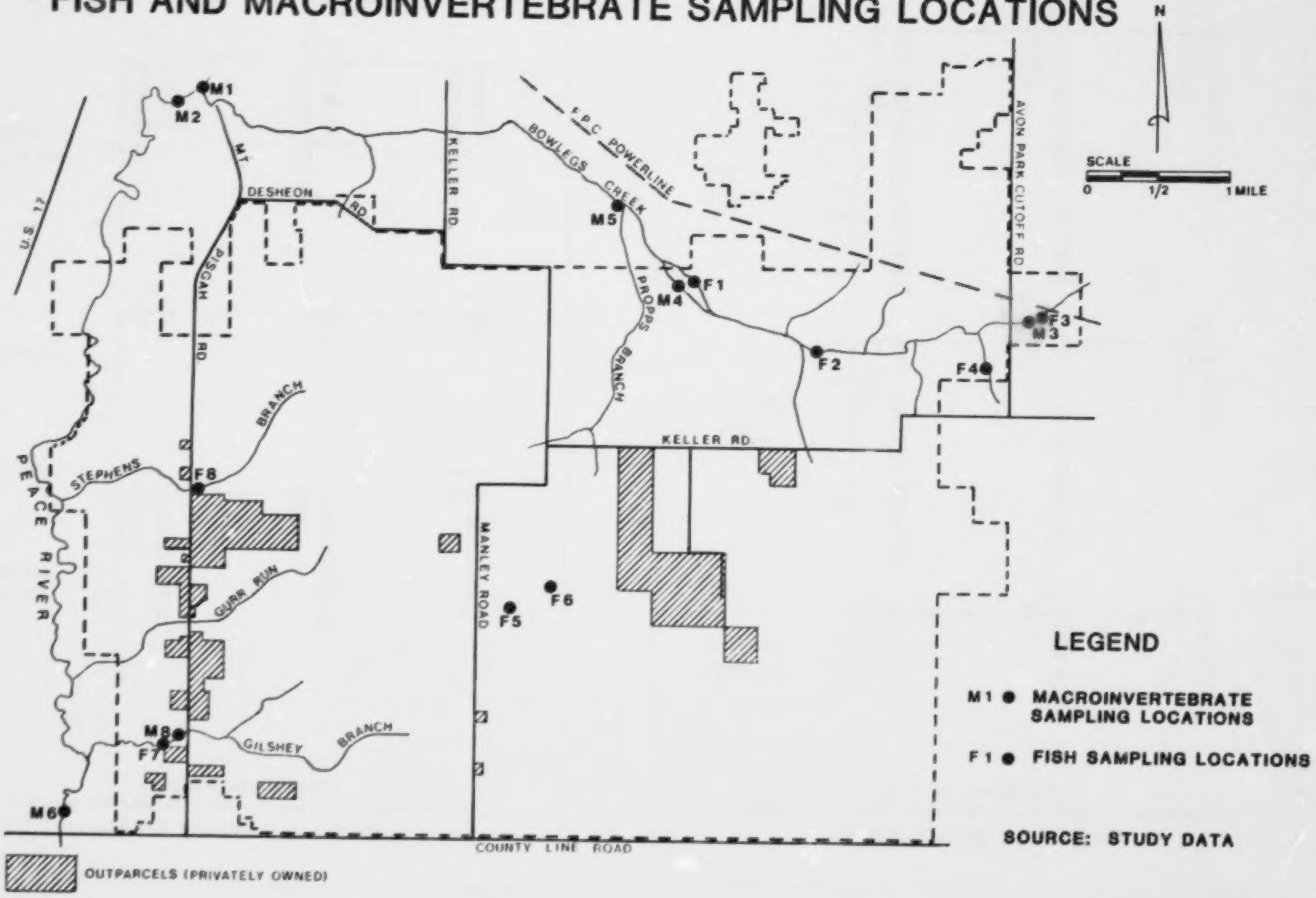
Benthic macroinvertebrate data were collected in September and December, 1979, to characterize the Peace River system near the site (Table 8-10, Figure 8-D). Forty-four taxa representing five phyla and seven classes were collected. Data were summarized and several indices relating species diversity, faunal similarity, equitability, and water quality were calculated (Table 8-11). Replicates were pooled and indices were calculated for the pooled values. In all cases of pooled replicates, total organisms exceeded 100 specimens.

The December sampling period displayed greater numbers of species (species richness), total numbers of individuals, and species density (numbers/m^2) than the September sampling (Figure 8-E). These differences could be attributed to seasonal shifts in population levels or related to sampling efficiency. September sampling was conducted under extremely high flow conditions which cause substrate scouring, destroying soft-bodied macroinvertebrates such as mayflies and dipterans. Peace River flow rates during September and October, 1979, were the highest recorded in five years at Fort Meade and could have caused flushing of the organisms.

Diversity values (Shannon and Weaver, 1963) of Peace River stations ranged from 0 to 1.04 for September and 2.08 to 2.47 for December. Wilhm (1970)

FIGURE 8-D

FISH AND MACROINVERTEBRATE SAMPLING LOCATIONS



LEGEND

M1 ● MACROINVERTEBRATE SAMPLING LOCATIONS

F1 ● FISH SAMPLING LOCATIONS

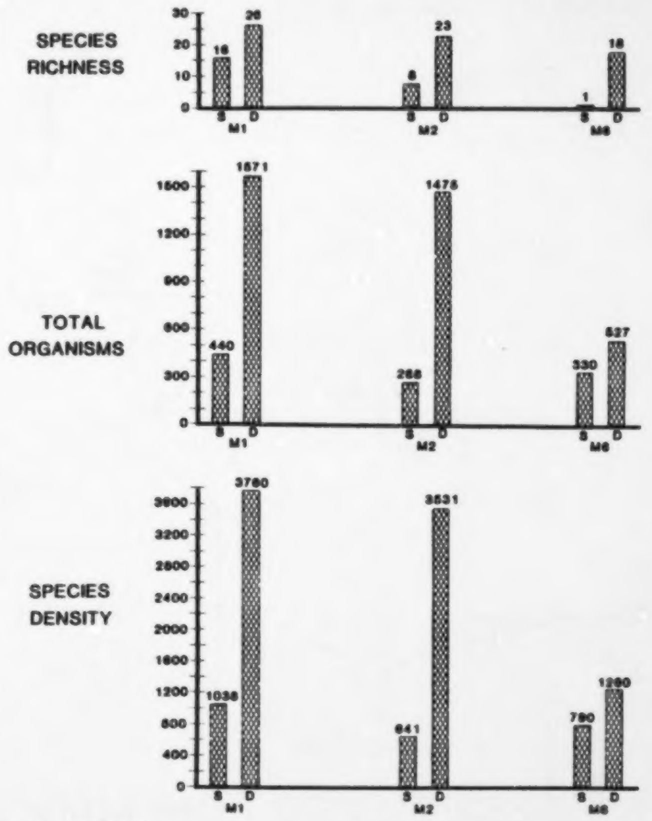
▨ OUTPARCELS (PRIVATELY OWNED)

SOURCE: STUDY DATA

FIGURE 8-E

PEACE RIVER STATIONS

BENTHIC MACROINVERTEBRATE SPECIES PARAMETERS
(POOLED REPLICATES)

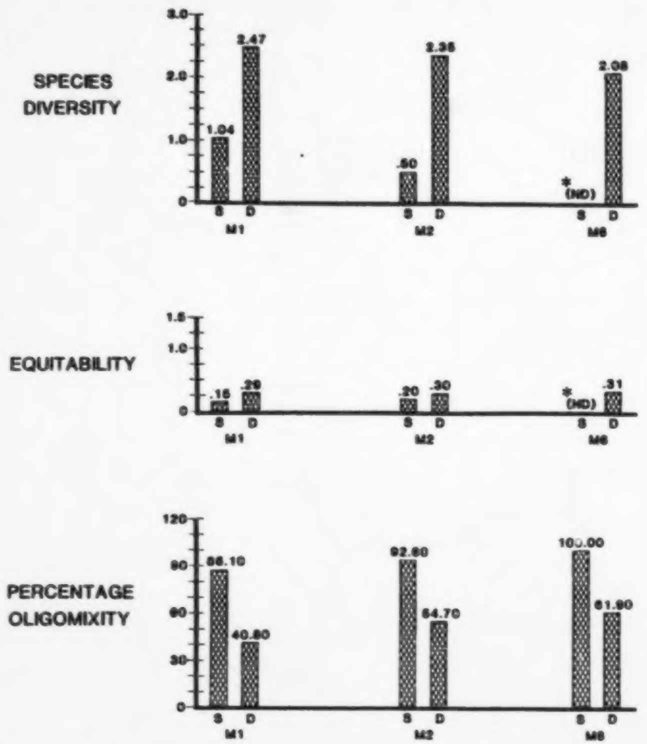


SOURCE: STUDY DATA

FIGURE 8-F

PEACE RIVER STATIONS

BENTHIC MACROINVERTEBRATE SPECIES PARAMETERS
(POOLED REPLICATES)



SOURCE: STUDY DATA

* (ND) - NOT DETERMINED

found that diversity values in unpolluted waters were generally between 3 and 4, and were less than 1 in polluted waters. However, studies in the southeast have indicated that where stream degradation is slight or moderate, the diversity index lacks the sensitivity to identify differences (EPA, 1973).

Equitability (MacArthur 1957, Lloyd and Ghelardi 1964, EPA 1973) was rather low, ranging from 0 to 0.20 for the September sampling period and from 0.29 to 0.31 during the December sampling period. Generally, equitability values of less than 0.5 are indicative of degradation (EPA, 1973). In addition, the Peace River benthic community exhibits high percentage oligomixity, or percentage dominance by a single taxon, indicating low diversity and a potentially stressed community (Thienemann, 1954) (Figure 8-F).

Florida index values (Beck, 1954 and 1955) were 10 or below, indicating the influence of organic pollution. Values of 10 or above indicate good water quality. Values for pooled replicates ranged from 3 to 10 in December and from 0 to 2 in September (Table 8-11); stress conditions are evident in both sampling periods.

Faunal similarity, based on Czekanowski's index (Boesch, 1977), was calculated for each station to estimate differences in community assemblages between stations and between sampling periods. Comparison of September and December sampling periods (pooled replicates) revealed a low to moderate community similarity between sampling periods. This indicates some shifts in community assemblages; however, September sampling may have been affected by extreme flows (Table 8-11).

Number of taxa, density, species diversity, and Florida index values decrease with distance downstream from Station M1 to M2 to M6. The decrease may reflect the relatively steep stream gradient and subsequent effects on flow velocities and substrate stabilities. Faunal similarity between stations was high during September sampling and moderate during December (Table 8-12).

In summary, the benthic macroinvertebrate community of the Peace River indicates a moderately stressed environment. Apparent seasonal trends may be a result of sampling efficiency during high flow conditions. Differences in environmental parameters with distance downstream may be the result of increasing flow velocities associated with the channel gradient of this area.

Fish: The Peace River basin contains at least 72 species of fish (Texas Instruments, 1977a). At least 35 species are present in southern Polk County (Table 8-13), most of them in the families Cyprinidae, Ictaluridae, Cyprinodontidae, and Centrarchidae. Members of these families are generally widely distributed within the basin.

Twenty-four exotic species are known to exist in the Central Florida Phosphate District (EPA, 1978), but only one, blue tilapia, is believed to be present in the Peace River near the site (Gilbert, 1977). Established breeding populations of this species in the Peace River system can denude stream vegetation and ultimately eliminate nearly all native herbivorous fish species. Blue tilapia may also replace native species in the ecologically weakened Peace River where fish kills have occurred (EPA, 1978).

Other Vertebrates: Several vertebrate species utilize stream communities to fulfill part or all of their ecological requirements (Table 8-4, 8-5, 8-6 and 8-7). Waterfowl and wading birds are the primary avian users, though their habitat is limited by the incised channel conditions near the site. Amphibians and reptiles characteristically include various water snakes, turtles, anurans and alligators. With the exception of turtles and alligators, herpetofauna (reptile and amphibian) use is generally limited to stream edges. The river otter and several chiropteran species also use the stream communities. This latter group utilizes lotic systems for feeding.

8.1.4.2 Bowlegs Creek

8.1.4.2.1 Ecological/Functional Description

Bowlegs Creek is the largest sub-basin within the proposed mine site, occupying 7,061 acres or 43 percent of the site. Lake Buffum and Boggy Branch are the principal contributors to the creek system (Figure 8-A). Seven intermittent tributaries within the site also contribute to the creek's flow. A portion of the creek on the site has been channelized and was at one time impounded with a small dam. Other influences include drainage from adjacent wetlands, agricultural runoff and phosphate mining discharges. Wetland influence is confined to high flow periods when wetlands are flushed and contribute organic material to the creek. Agricultural runoff and phosphate mining have contributed to an increase in nutrients and a general decline in water quality of Bowlegs Creek as compared to the average state-wide water quality (Bowlegs Creek, Section 7.1.4.2). Like the Peace River, Bowlegs Creek flow regimes are seasonal. Stream gradients and velocities are less extreme than the Peace River and channel scour is not as intense. Ecologically, Bowlegs Creek is similar to other detrital-based systems in the region. Floral and faunal diversity is low to moderate, but higher than values found in the Peace River. The wildlife habitat value of the system is also low to moderate, primarily due to influences of surrounding land uses such as mining, livestock grazing and citrus production. The creek offers some aesthetic value and recreational value.

8.1.4.2.2 Flora

Algae: Algal communities in Bowlegs Creek are similar to those in the Peace River. Periphyton and phytoplankton assemblages of Bowlegs Creek are somewhat limited by overstory shading of the stream. One channelized area has good light penetration and consequently has more diverse and abundant algal communities than are found elsewhere in the creek.

Aquatic Macrophytes: Aquatic vascular plants occurring within Bowlegs Creek are similar to those identified within the Peace River, though their distribution is limited by shade from overhanging trees. The channelized portion, however, supports a substantial growth of smartweed.

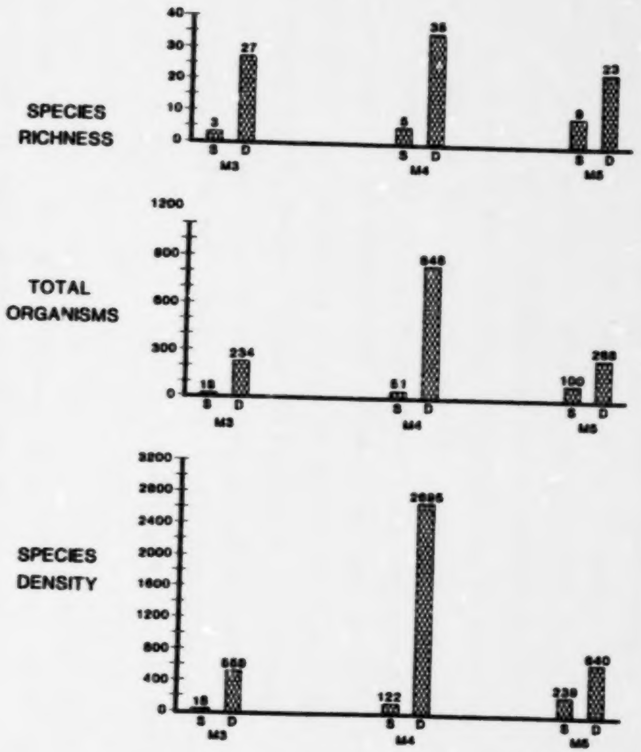
8.1.4.2.3 Fauna

Macroinvertebrates: A total of 49 macroinvertebrate taxa were collected from Bowlegs Creek during the two sampling periods (Table 8-14). Species richness, total number of organisms, and species density were higher during the December sampling period than during the September period (Table 8-15, Figure 8-G). This may result from stream flow phenomena and subsequent effects on substrate stability, or it may be an indication of sampling efficiency during high flow situations. Pooled values for September were based on 100 or fewer specimens (Table 8-15), and comparison with December pooled values should be made with caution.

FIGURE 8-G

BOWLEGS CREEK STATIONS

BENTHIC MACROINVERTEBRATE SPECIES PARAMETERS
(POOLED REPLICATES)

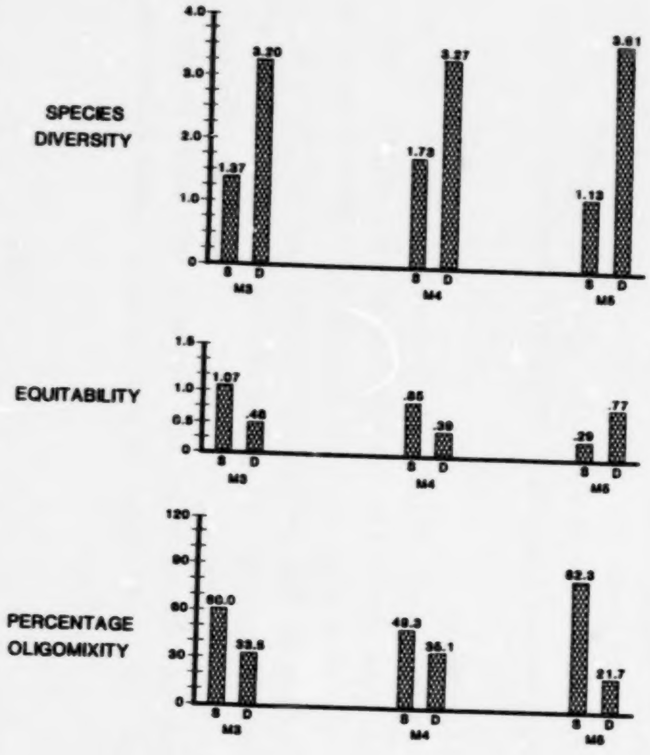


SOURCE: STUDY DATA

FIGURE 8-H

BOWLEGS CREEK STATIONS

BENTHIC MACROINVERTEBRATE SPECIES PARAMETERS
(POOLED REPLICATES)



SOURCE: STUDY DATA

Species diveristy values ranged from 1.13 to 1.73 during September and 3.2 to 3.6 during December (Figure 8-H). Equitability values ranged from 0.29 to 1.07 for the September collection and 0.39 to 0.77 for December. Equitability values for the December sampling period were generally higher than those for the Peace River, indicating that benthic faunal communities in Bowlegs Creek are less stressed than those in the Peace River system. Percentage oligomixity was moderate, also indicating a relatively ecologically healthier community. Faunal similarity between seasons was low, possibly as a result of sampling efficiency. Additionally, the total number of organisms collected in September was less than 100, making comparison of seasonal trends difficult. Florida index values ranged from 0 to 7 for September and from 13 to 18 for December. December values indicate a relatively organic pollutant-free system. All faunal similarity values between stations were less than 0.50; values were lower during the high flow period (September) than during the decreasing flow period (December) (Table 8-12).

Comparison of ecological parameters of Bowlegs Creek (Table 8-15) and the Peace River (Table 8-11) indicates that Bowlegs Creek contains a more diverse and a less stressed benthic community than does the Peace River. Faunal similarity between Bowlegs Creek and Peace River collections was low (Table 8-12). Of the 44 taxa found in the Peace River, only 23 (52 percent) are common to the benthic community of Bowlegs Creek. This suggests that under natural conditions Bowlegs Creek is not a major source of colonizer organisms for the Peace River. With 52 percent of the benthic organisms common between the two systems, Bowlegs Creek has the potential to serve as a source of colonizer organisms should an adverse event occur in the Peace River.

Fish: A total of 18 fish species were collected from three sampling sites on Bowlegs Creek (Table 8-16). Station F2 contained the most taxa and total individuals; this station was in a channelized portion of the stream which supported a dense growth of smartweed. The most abundant fish collected at F2 was the bluegill (32.6 percent of the total number), a member of the sunfish family which feeds primarily on insects and smaller fish species. Centrarchids made up the majority of the fish species collected at this station (54.7

percent of the total). Upstream (Station F3), the most abundant fish collected was the golden topminnow. The sunfish group comprised 33.5 percent (24.1 percent of total) of species captured. The eastern mosquitofish (41.2 percent) and southern brook silverside (39.5 percent) were codominants at Station F1. One exotic, the walking catfish, was collected from Bowlegs Creek at Station F2 and comprised 4 percent of the total individuals collected.

Other Vertebrates: Birds, mammals, amphibians and reptiles occasionally utilizing Bowlegs Creek are similar to those found on the Peace River (Tables 8-4, 8-5, 8-6, and 8-7).

8.1.4.3 On-Site Tributaries

8.1.4.3.1 Ecological/Functional Description

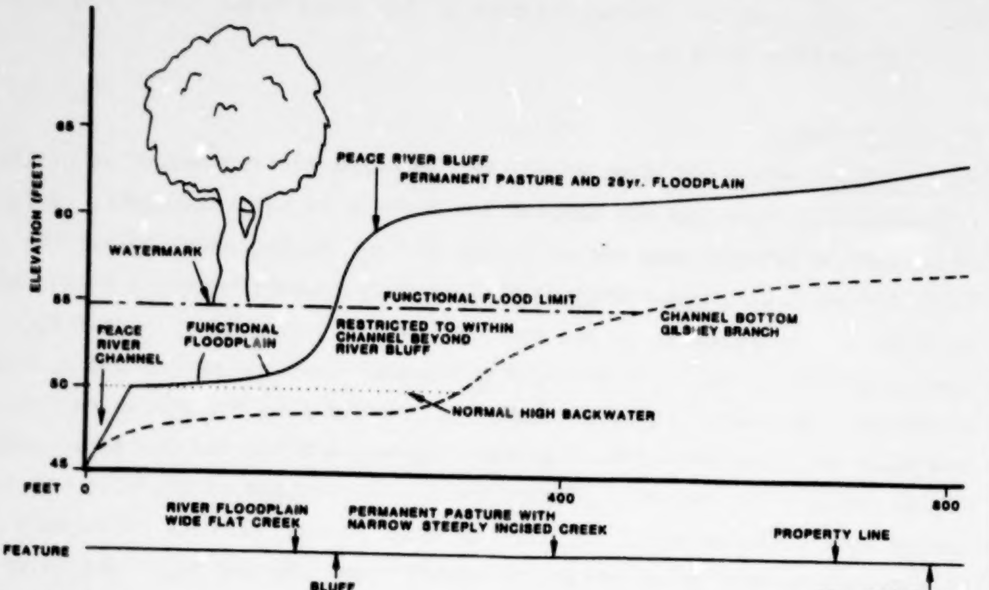
The ten tributaries on the site have their headwaters in plateau depressions. All the channels tend to be deeply incised; several have been channelized to enhance drainage. The tributaries have highly variable flows due to seasonal rainfall and surficial aquifer seepage. Annual average flows are less than 5 cfs and are highly variable, limiting biotic community stability. Shading of the streams limits light penetration important to algae communities and decreases primary production. Aesthetic and recreational values of the tributaries are minimal, though aesthetic value increases where cattle have been excluded and overstory remains intact. Flooding and ordinary backwater flow from the Peace River and Bowlegs Creek are restricted to the vicinity of the tributary confluences (Figures 8-I and 8-J). These tributaries, therefore, serve primarily as conveyances for excess water that accumulates in the plateau depressions during precipitation.

8.1.4.3.2 Flora

Algae: Periphyton and phytoplankton communities of the small intermittent streams on site are limited by dense overhang and subsequent poor light penetration. Cattle watering ponds and off-channel wetlands are the primary sources of algal communities in the tributaries. These areas fill and overflow into connecting ditches in the headwater areas of the streams carrying biota downstream during heavy rains.

FIGURE 8-I

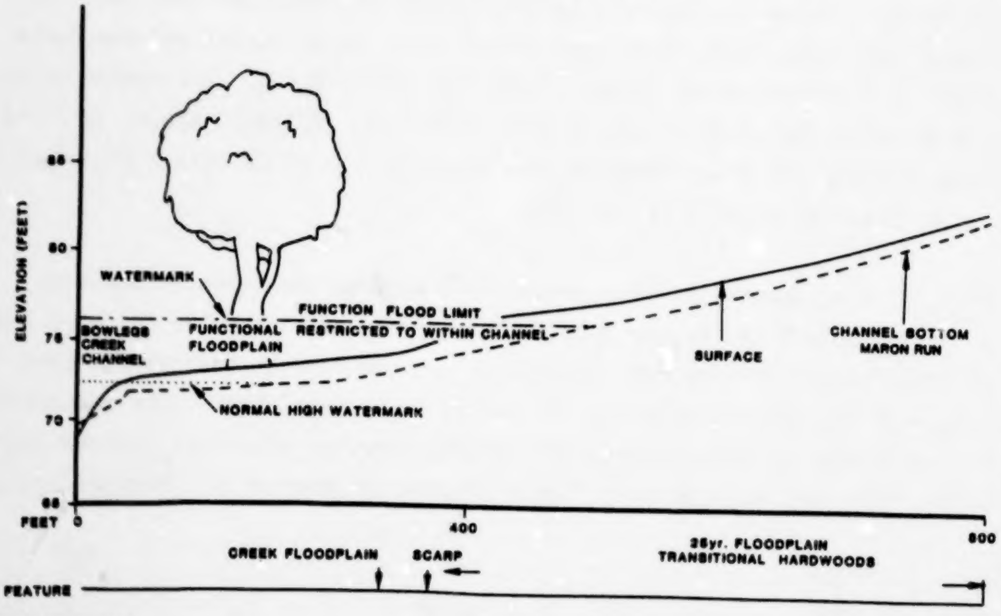
GILSHEY BRANCH / PEACE RIVER INTERFACE
STRUCTURAL / FUNCTIONAL RELATIONSHIPS


ELEVATION (FEET)
65
60
55
50
45
FEET 0
400
800
PEACE RIVER BLUFF
PERMANENT PASTURE AND 25yr. FLOODPLAIN
WATERMARK
FUNCTIONAL FLOOD LIMIT
PEACE RIVER CHANNEL
FUNCTIONAL FLOODPLAIN
RESTRICTED TO WITHIN CHANNEL BEYOND RIVER BLUFF
CHANNEL BOTTOM GILSHEY BRANCH
NORMAL HIGH BACKWATER
RIVER FLOODPLAIN WIDE FLAT CREEK
PERMANENT PASTURE WITH NARROW STEEPLY INCISED CREEK
PROPERTY LINE
FEATURE
BLUFF
25yr. FLOODPLAIN

SOURCE: STUDY DATA

FIGURE 8-J

MARON RUN / BOWLEGS CREEK INTERFACE
STRUCTURAL / FUNCTIONAL RELATIONSHIPS



SOURCE: STUDY DATA

Aquatic Macrophytes: Aquatic vascular flora are limited in the tributaries. Species composition is similar to that of the Peace River basin (Table 8-9), but distribution is sparse.

8.1.4.3.3 Fauna

Macroinvertebrates: Gilshey Branch was selected as representative of the tributaries on site and was sampled for benthic faunal components. A total of 58 macroinvertebrate taxa was collected during the two sampling periods (Table 8-17, Figure 8-D) . Community characteristics exhibit seasonal trends similar to those of the Peace River and Bowlegs Creek (Table 8-18, Figure 8-K). Species diversity was 3.45 during the December sampling period and 3.26 during September. However, the total number of organisms in the pooled replicate for September was less than 100. Equitability was 0.8 for the September sampling period and 0.3 for December (Figure 8-K). Percentage oligomixity was low during both sampling periods. Florida index values indicate relatively clean (low oxygen demand) water during decreased flows (pooled replicate value was 25), as based upon indicator organisms (Table 8-18). Values, however, fell below 10 during the high flow period (Table 8-18). Ponds at the headwaters are usually stagnant and eutrophic, releasing water only during precipitation extremes.

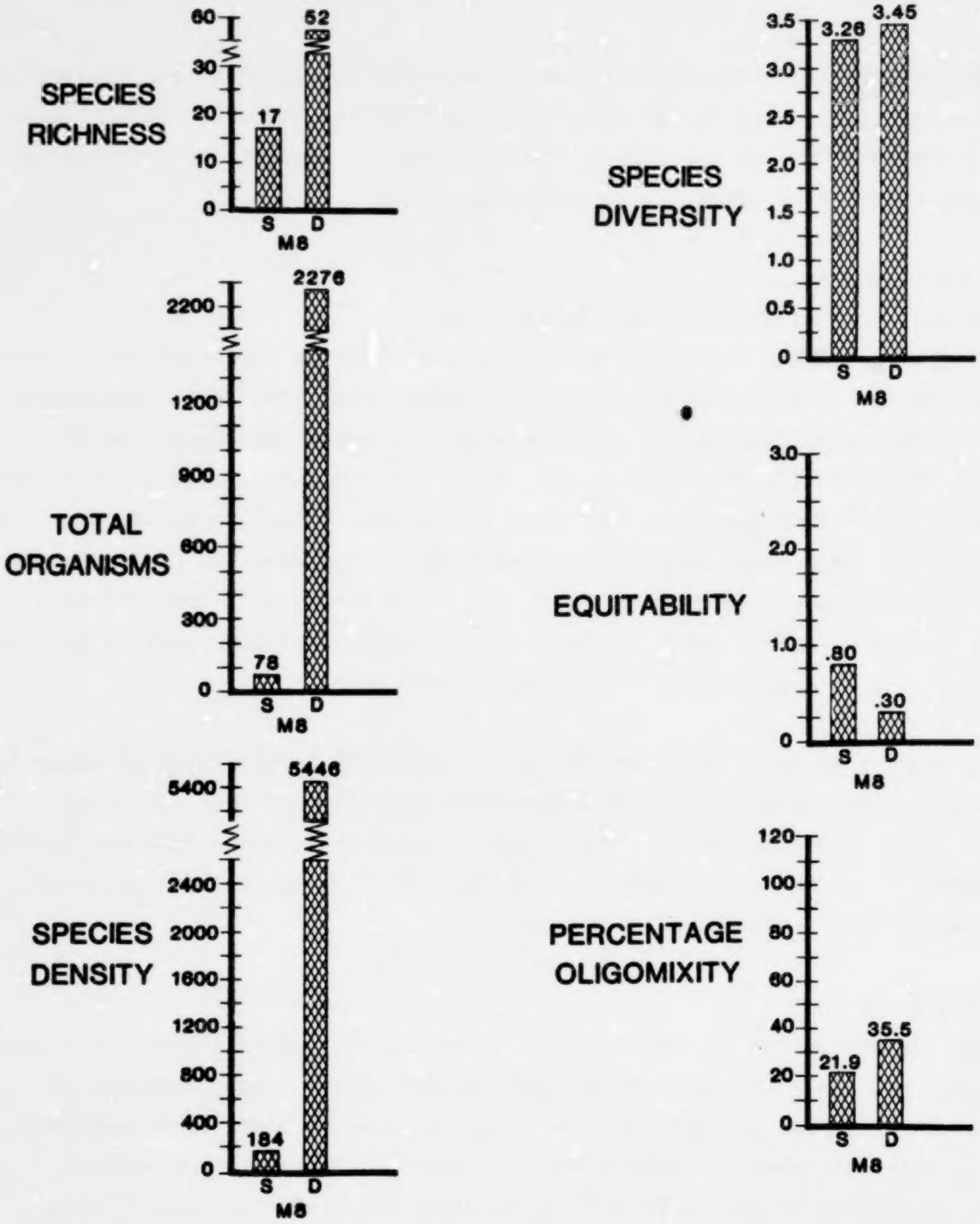
Faunal similarity between seasons was low (Table 8-18), indicating a shift in the faunal community; however, September samples contained less than 100 organisms. Comparison of Gilshey Branch with Bowlegs Creek and the Peace River also indicated low faunal similarity (Table 8-12). The number of taxa common to the Peace River and Gilshey Branch was 26 (59.1 percent of Peace River total). This may indicate that contribution of colonizer organisms by the tributaries on site is not high.

Fish: Eleven species of fish were collected from the three tributaries sampled (Table 8-19, Figure 8-D). The majority of fish collected were from Gilshey Branch (Station F7). Except in extreme drought conditions, this station flows year-round while the others are intermittent. The eastern mosquitofish was the only species collected at Station F8. This species and the yellow bullhead were the only fish collected at Station F4. Ten species of

FIGURE 8-K

GILSHEY BRANCH STATION

BENTHIC MACROINVERTEBRATE SPECIES PARAMETERS
(POOLED REPLICATES)



SOURCE: STUDY DATA

fish were collected at Station F7, with the sailfin molly the most abundant (34 percent of total individuals). The Poeciliidae was the dominant group collected on Gilshey Branch (59 percent of total), while the sunfish family comprised approximately 21 percent of individuals collected on Gilshey Branch. The species found in the creek are generally tolerant of low dissolved oxygen conditions.

Other Vertebrates: Presence of mammals, amphibians, reptiles, and birds on or within the tributaries is extremely limited. Turtles and other larger reptiles are rare, due to low stream flow conditions. Terrestrial vertebrates use the tributaries primarily for water and food.

8.1.4.4 Ponds

8.1.4.4.1 Ecological/Functional Description

The South Fort Meade Mine site contains man-made cattle ponds and naturally occurring unvegetated reservoirs. Cattle ponds, the major lentic community type on the site, exhibit low vascular plant and animal abundance and diversities due to cattle grazing and trampling. The ponds generally are eutrophic because of the high nutrient input from cattle use. Algal community abundance is high with many ponds supporting algal blooms. Hydroperiods of the naturally occurring unvegetated reservoirs range from perennially wet to intermittent systems maintained by surface runoff and/or surficial aquifer seepage. The man-made ponds generally contain water year-round.

The primary functional value of the lentic community is provision of water for livestock. During extreme rains these ponds provide nutrients and excess water to on-site tributaries. Water quality benefit is negligible due to the eutrophic condition of the ponds. Provision of wildlife habitat, aesthetics and recreational value is also limited.

8.1.4.1.2 Flora

Algae: Investigation of lentic algae in central Florida is limited to a study of temporary pools and ponds in northern Desoto County (Texas Instruments, 1977a). Periphyton collections from these small water bodies indicate that green algae is generally dominant in each season. Phytoplankton surveys indicate density dominance by both green algae and bluegreen algae (Texas

Instruments, 1977a). Ponds on the site are generally eutrophic and support algal blooms.

Aquatic Macrophytes: Little aquatic vegetation was found in ponds on the site, due primarily to cattle grazing and trampling in pond areas. Aquatic vegetation was primarily water hyacinths, cattail and duckweed.

8.1.4.1.3 Fauna

Macroinvertebrates: Macroinvertebrate collections were not made in any ponds on site. A recent study of temporary pools and ponds in Desoto County indicates a relatively low faunal diversity (Texas Instruments, 1977a). Tubificid worms and larval insects such as ceratopogonids are common in small shallow water bodies. Extreme water level fluctuations are believed to be responsible for the low diversity and abundance of higher crustaceans and mollusks (Texas Instruments, 1977a).

Fish: Fish species occurring in these ponds and unvegetated reservoirs are tolerant of environmental extremes and exhibit a short life cycle coupled with a high reproductive capability. The native fish assemblage in this habitat type includes the golden topminnow, least killifish, sailfin molly, blue-spotted sunfish, Everglades pygmy sunfish and eastern mosquitofish. The latter species is usually dominant in this community.

Other Vertebrates: The value of these ponds for vertebrate species is low, being limited almost entirely to usage by cattle. Some anurans use these sites for breeding.

8.1.5 FORESTRY AND AGRICULTURAL RESOURCES

Agricultural resources, including pasture, cropland and citrus, total 8,282 acres (50.8 percent) on the proposed mine site. Of this, 6,876 acres (80.3 percent) are in improved pasture supporting a variety of native and introduced grasses including bahia, bermuda, smut grass, love grasses, sandspur, panic grasses, and carpet grass.

Row crops and field crops comprise 840 acres or 5.2 percent of the site. Row crops are grown on several commercial farms near the southeast corner of the site and include cucumbers, squash, corn, peppers and tomatoes. A single 30-acre tract near the north central property boundary is in field crops. None of the soils on the site are designated as prime agricultural soils (Section 4.1.7.3 Unique Agricultural Lands).

Citrus is a major agricultural product in the central Florida area, accounting for about one-third of the state's total citrus acreage (EPA, 1978). Polk County accounts for approximately one-half of this. Citrus groves, primarily oranges, occupy 566.2 acres or 3.5 percent of the total site. The groves are located along Mt. Pisgah Road and in the northeast corner of the site. Citrus groves require intensive management (cultivation and herbicide treatment for weed control, foliar spraying for insect and disease control, pruning and labor-intensive fruit harvesting) in order to obtain maximum yields. Most groves on the site are not at peak production due to age and lack of adequate management.

The SCS has designated most of the citrus land in central Florida as unique citrus areas. Approximately 72 percent of the 200,200 acres of citrus groves in Polk County are designated as unique citrus areas. Of the 566 acres of orange groves on the proposed mine site, 446 acres or 79 percent are identified in this category. They constitute less than 0.5 percent of the Polk County total.

Planted pine (slash pine) occupies approximately 340.1 acres (2.1 percent of the site). Pine plantations occur in three areas on the site (Figure 8-B). The pines are approximately 6 inches diameter at breast height (dbh), about 40 feet high, and appear to have been planted at approximately the same time. A survey of the forestry resources indicates that the equivalent of 4,153 cords of wood are on the planted pine sites.

8.1.6 MIGRATORY WILDLIFE AND GAME SPECIES

Large game species potentially present on the site include the feral hog and the white-tailed deer. The feral hog population appears abundant on the site; however, no white-tailed deer were observed on site. It is doubtful that a sufficient white-tailed deer population exists for any hunting use. Small game species consist primarily of mourning doves, bobwhites, gray squirrels, eastern cottontails and marsh rabbits. Fur-bearing species include the raccoon, bobcat, fox and skunk. Bobwhites, gray squirrels and mourning doves are abundant while the other species do not occur in large numbers. Hunters' shell casings indicate that game birds are the primary target; however, hunting is limited as the land is privately owned.

Although the site is on the migratory flyway, the poor quality of marshes and the small size of water bodies preclude any appreciable use of the site by migratory ducks, wading birds or other waterfowl. Habitats of potential use by migratory species have been degraded by livestock, commercial and agricultural modifications.

The Peace River is the only commercially fishable water on the site, although it presently is utilized almost exclusively by sport fishermen. Commercial operations are associated with Polk County lakes off the site.

8.1.7 RARE AND ENDANGERED SPECIES

8.1.7.1 Federally Threatened or Endangered Species

EPA provided (December 12, 1980) the U.S. Fish and Wildlife Service, Jacksonville, Florida office with a description of Mobil's South Fort Meade Mine project and requested a list of endangered and threatened species which might occur in the project's area of influence. The U.S. Fish and Wildlife Service responded (December 18, 1980) to the EPA request with the following listing of species believed to be present in the area:

Bald Eagle - Endangered
Red-Cockaded Woodpecker - Endangered
Eastern Indigo Snake - Threatened
American Alligator - Threatened.

A summary discussion of each of the wildlife species' habitat requirements and their occurrence in the region is presented in the following paragraphs. No Federally threatened or endangered plant species were identified on site.

Southern Bald Eagle: The southern bald eagle is usually found in riparian habitats. The species nests are usually located near large bodies of water, although in the Florida interior they may nest on ponds and marshes. An eagle nest is present near the northeastern site boundary, but is not within the project boundaries. The proposed mine site does not have nesting habitat characteristic of this species, but may have areas being utilized for feeding.

Red-Cockaded Woodpecker: Red-cockaded woodpeckers are generally associated with mature to overmature longleaf pine stands. No mature stands of other pines which could provide habitat for this species exist on the site. There were no observations or reported sightings of this species. It is concluded that the possibility of a red-cockaded woodpecker occurring on the proposed mine site is extremely low to nonexistent.

Eastern Indigo Snake: The indigo snake was observed on the proposed mine site. This species prefers mesic forests and hardwood wetlands. They are also found in xeric habitats associated with burrows of the gopher tortoise and other species. The five sightings of indigo snakes were in mesic habitats along Bowlegs Creek, the Peace River, and near the on-site tributaries.

American Alligator: Alligators occur in small populations on the proposed mine site. This species is rather adaptive and was observed in a few cattle ponds and drainage canals. Poaching was evident as one alligator was found shot. There is adequate alligator habitat on the site but the habitat disturbances associated with cattle production have restricted this species' distribution on the property.

8.1.7.2 State Rare and Endangered Species

Twenty-four protected plants listed as endangered, threatened, or of special concern under Florida Statute 581.185 (Preservation of Native Flora of Florida) occur on the proposed mine site (Table 8-20). The stated intent of

Florida Statute 581.185 is "...to provide an orderly and controlled procedure for harvesting native flora from the wilds, thus preventing wanton exploitation or destruction of Florida native plant populations." The observed species fall into this category. Their distribution on site is restricted primarily to the periphery and wooded strips along the Peace River, Bowlegs Creek and tributaries. Much of this habitat has been severely degraded by cattle grazing and man-related activities such as drainage of wetlands, controlled burning, and clearing for agricultural and forestry interests, thus reducing the value of these areas for the listed species. None are presently in danger of extinction from the state.

Animal species listed below have been classified as endangered, threatened, or of special concern by the Florida Game and Fresh Water Fish Commission.

Wood Stork - Endangered
Florida Sandhill Crane - Threatened
Sherman's Fox Squirrel - Special Concern
Gopher Tortoise - Special Concern
Florida Burrowing Owl - Special Concern
Little Blue Heron - Special Concern
Snowy Egret - Special Concern
Louisiana Heron - Special Concern.

Wood Stork: One sighting of a wood stork occurred during the field studies. The cypress swamp was checked for nests, and none were found. The site habitat for this species is limited and of poor quality. It is likely that this sighting was non-characteristic, and the wood stork sighted was a visitor to the site.

Florida Sandhill Crane: This species was observed at four locations on the mine site. They are thought to be residents since the site contains pasture and freshwater marsh, their preferred habitat.

Sherman's Fox Squirrel: Two Sherman's fox squirrels were observed on site in uncharacteristic habitat. The small size and poor quality of longleaf pine habitats on site suggest that the fox squirrel population is small.

Gopher Tortoise: This species was observed on site. The gopher tortoise occurs in habitats on xeric, sandy soils; however, much of this land is now in pasture and there are only a very few active burrows left.

Florida Burrowing Owl: The Florida burrowing owl was observed on the proposed mine site. Almost all pastures on site with dry, sandy soil have active owl burrows. In one pasture 12 active owl burrows were found.

Little Blue Heron, Snowy Egret, and Louisiana Heron: These species were observed on the proposed mine site. All sightings included a low number of individuals and no rookery areas were found. Their wetland habitats on the site are either small or of poor quality.

8.1.8 WETLANDS CLASSIFICATION

Federal jurisdiction over wetlands is based primarily on Section 404 of the Clean Water Act of 1977 (33 USC, 1344), formerly known as the Federal Water Pollution Control Act, in which wetlands are defined, their uses and values described and a basis for regulation presented. Subsequently, vegetation lists were developed to assist in defining wetlands (U.S. Army Corps of Engineers, 1978), and a functional and physical approach to wetland classification has been developed (Cowardan et al., 1977). Reppert et. al (1979) provide a technical concept and procedure for evaluation of wetlands based on the requirements of the Clean Water Act. The procedure emphasizes ecosystem functional criteria and structural characteristics rather than the presence of certain species as criteria. This provides a basin-wide assessment among widely varying wetland types and allows an evaluation of a particular site as a unit within a larger system.

In the Final Areawide Environmental Impact Statement for the Central Florida Phosphate Industry (EPA, 1978) the U.S. Environmental Protection Agency established a wetlands categorization system to serve as a guideline for regulating the mining and reclamation of wetlands. This system entailed the assignment of wetlands on new source mine sites into one of three categories:

Category 1 -- Preserved and Protected

Wetlands within and contiguous to rivers and streams having an average annual flow exceeding 5 cubic feet per second as well as other specific wetlands determined to serve essential environmental functions, including water quality. (These are wetlands that provide an essential synergistic support to the ecosystem and that would have an unacceptable adverse impact if they were altered, modified, or destroyed.) This generally includes cypress swamps, swamp forests, wet prairies, and certain freshwater marshes.

Category 2 -- Mine and Restore

Wetlands that should be restored as wetlands to perform useful wetland functions. This also includes certain isolated noncategory wetlands that serve a primary function or several minor functions that may be maintained through proper restoration.

Category 3 -- Mine With No Restoration to Wetlands

Wetlands that would not have to be restored as wetlands. These are isolated and normally intermittent in nature, have less significant hydrological functions than Category 2, and minimal life-support value.

The wetlands identified on the proposed South Fort Meade Mine Site (Figure 8-L) have been defined and evaluated according to the requirements of Section 404 of the Clean Water Act and then categorized according to the guidelines presented in the Areawide EIS (EPA, 1978).

The Reppert et al.(1979) procedure supplemented with a Delphi technique for weighting criteria was utilized to conduct a site-specific determination of wetlands and their functional significance on the proposed site. The Delphi technique and criteria weighting were employed because it was considered necessary to involve all key agency decision-makers in assigning weightings to wetland values and because the basic methodology assumed all wetland values

FIGURE 8-L

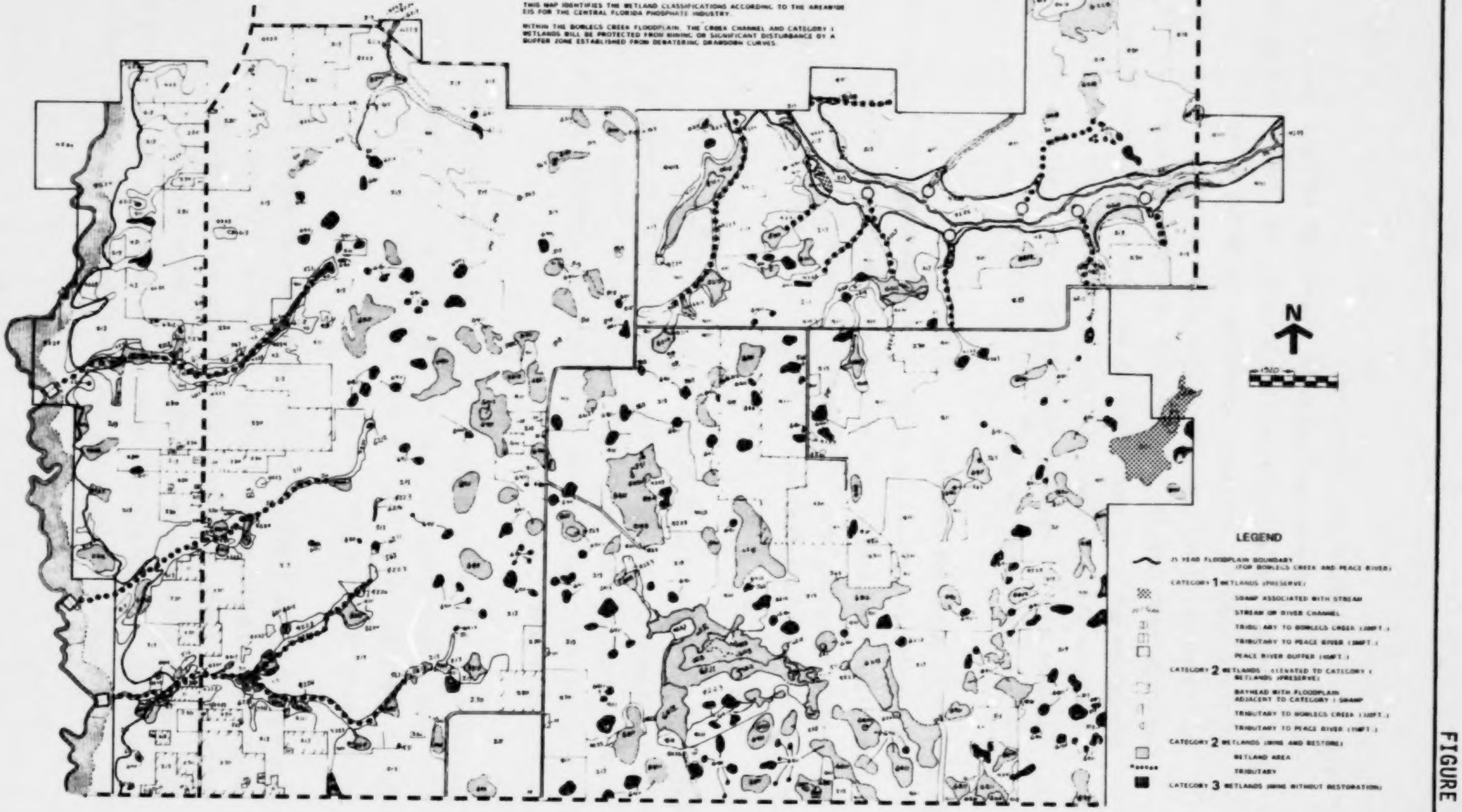
WETLAND DELINEATION MAP

PROPOSED SOUTH FORT MEADE MINE SITE
MOBIL CHEMICAL COMPANY

EPA APPROVED - JUNE 25,1980

THIS MAP IDENTIFIES THE WETLAND CLASSIFICATIONS ACCORDING TO THE AREAWIDE EIS FOR THE CENTRAL FLORIDA PHOSPHATE INDUSTRY.

WITHIN THE BOWLEGS CREEK FLOODPLAIN, THE CREEK CHANNEL AND CATEGORY 1 WETLANDS WILL BE PROTECTED FROM MINING OR SIGNIFICANT DISTURBANCE BY A BUFFER ZONE ESTABLISHED FROM DEWATERING DRAWDOWN CURVES.


N
LEGEND
25 YEAR FLOODPLAIN BOUNDARY (FOR BOWLEGS CREEK AND PEACE RIVER)
CATEGORY 1 WETLANDS (PRESERVE)
SWAMP ASSOCIATED WITH STREAM
STREAM OR RIVER CHANNEL
TRIBUTARY TO BOWLEGS CREEK ([illegible])
TRIBUTARY TO PEACE RIVER ([illegible])
PEACE RIVER BUFFER ([illegible])
CATEGORY 2 WETLANDS (ELEVATED TO CATEGORY 1 WETLANDS (PRESERVE)
BAYHEAD WITH FLOODPLAIN ADJACENT TO CATEGORY 1 SWAMP
TRIBUTARY TO BOWLEGS CREEK ([illegible])
TRIBUTARY TO PEACE RIVER ([illegible])
CATEGORY 2 WETLANDS (MINE AND RESTORE)
WETLAND AREA
TRIBUTARY
CATEGORY 3 WETLANDS (MINE WITHOUT RESTORATION)

criteria were equally important. Polling of the key decision-makers at an early stage in the evaluation process not only provided a relative ranking of wetland valuation criteria but also produced a consensus position for probable values of wetland units on the site. Site-specific conditions were used to assist in establishing the baseline from which the evaluation and categorization were made. The results of the wetlands study are summarized in Figure 8-L and in the following subsections. The complete report of the study entitled "South Fort Meade Mine Tributary Functional Analysis to Support an Assignment of EPA Wetland Categories" can be obtained from EPA upon request.

8.1.8.1 Category 1 Wetlands

For Bowlegs Creek and the Peace River, the 5 cfs flow points occur upstream of the Mobil South Fort Meade Mine site. Therefore, wetlands within the areas contiguous to these systems were designated Category 1 to be protected from mining. These wetlands were limited in extent because of local topography (steep banks) but were assumed to meet or exceed both the EPA (1978) and Army Corps of Engineers (Reppert et al., 1979) criteria for valuable and important wetlands within the context of Section 404.

Tributaries to these two flowing systems had less than 5 cfs as a mean annual flow at their mouths. The species similarity of the tributaries and receiving systems was low. Interchange of species between the systems was minimal, and contribution of materials and species from the smaller tributaries to the much larger river and creek systems was shown to be minimal. Zero and very low flow conditions were usual occurrences for the tributaries. Therefore, the break between Category 1 and Category 2 systems was placed at the flood backwater point indicated by the elevation of the water line on trees along the Peace River and Bowlegs Creek.

Category 1 depression wetlands in the plateau included a large cypress dome near the eastern boundary of the site. This 75-acre dome is open in the center with several strata of vegetation. It provides some fish and wildlife habitat value.

8.1.8.2 Category 2 Wetlands

Category 2 wetlands can be mined but restoration is required. This category includes the small tributaries, whose primary function is to convey excess flow from the site interior to the Peace River and Bowlegs Creek, and the smaller seasonally flooded plateau depression wetland units.

The small tributaries contributing to the Peace River and Bowlegs Creek from the property have less than 5 cfs annual average flow. They exhibit steep channel gradients and are dependent on low volume seepage for minimal flow maintenance. The biotic similarity, as based on benthic macroinvertebrates, is low between the tributaries and the Peace River and Bowlegs Creek. Flooding and ordinary backwater flow from the Peace River and Bowlegs Creek into these tributaries are restricted to the immediate vicinity of the tributary mouths (Figure 8-I and 8-J). Lateral spreading or tributary flooding is severely restricted by the narrow, deep channel incisions above the Peace River and Bowlegs Creek floodplains. The incision effectively isolates the floodway wetland vegetation from the throughput of waters and further minimizes the ability of the wetlands to provide retention, storage, habitat and food chain production functions as an internal capability or in support of downstream units.

Category 2 depression units do not support a wide range of aquatic animal species because of their shallow seasonal flooding and isolation from stocks to recolonize the area when flooding occurs. Organic or peaty materials accumulate slightly or not at all in the depressions, although the soil may have a relatively high organic content. The wetland characteristics and vegetation in many of these units are maintained by adequate soil moisture conditions rather than by the sustained presence of surface water which would result in great functional importance of the units. This combination of factors results in minimal aquatic system value.

8.1.8.3 Category 3 Wetlands

These small depression wetlands are less than 5 acres each in size, typically are flooded for a shorter period than larger units, do not accumulate organic or peat layers because of limited water retention, and develop aquatic characteristics and values to a lesser degree than do more permanent units. Their connections to other units are minimal, and their ability to provide materials and services to other systems is correspondingly small. These units usually are isolated and scattered over the plateau, and are viewed as small, very shallow depressions with patches of herbaceous wetland species. Cattle grazing, mowing and periodic burning serve to further limit their development or alter their character and minimize their value as wetlands.

8.1.9 METHODOLOGY AND QUALITY ASSURANCE

8.1.9.1 Methodology

8.1.9.1.1 Terrestrial Resources

Vegetation Mapping: Imagery sources used to define vegetation and wetlands included the following:

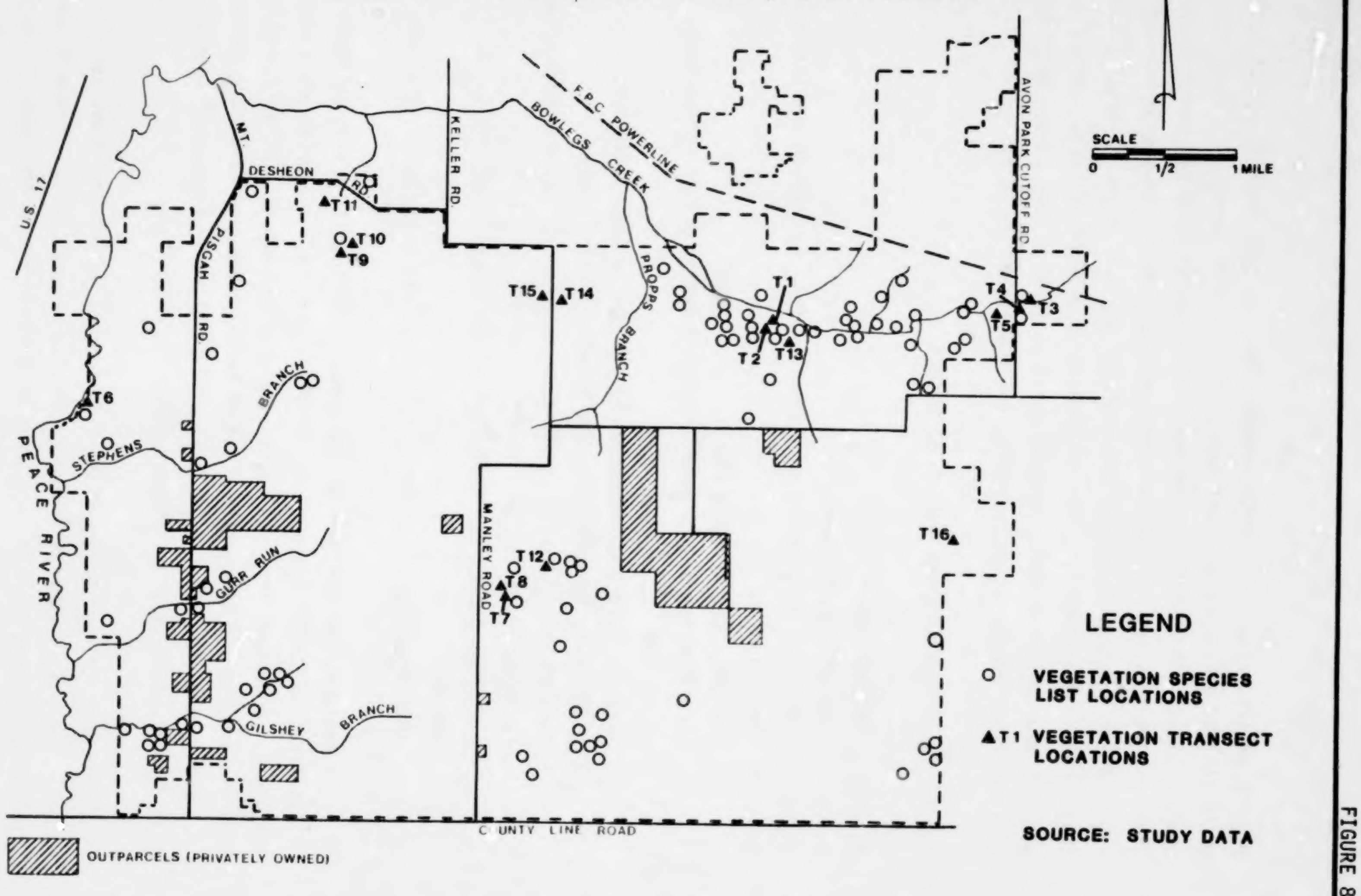
- 1927 Polk County Soils Map
- 1968 (February) ASCS black-and-white aerial stereo photography (1:20,000)
- 1970 and 1972 USGS photorevised 7.5-minute quadrangle maps (1:24,000), Bowling Green and Bereah, Florida sheets
- 1973 (October) USGS high altitude false color infrared photography (1:80,000)
- 1975 Polk County Tax Assessors Office aerial bluelines (1 in. = 400 ft.)
- 1980 Breedlove Associates, Inc. color and false color infrared obliques

Habitat designations and mapping followed the Florida Land Use and Cover Classification System (Kolb et al. 1976). Level III categories and Level IV categories developed for this study were used in mapping. After a preliminary map was prepared, a site visit was made to all cover and land use associations to correct any discrepancies. Total acreage of each delineated association was determined by polar planimetry.

Vegetation Transects: Representative stands, of each major plant association were chosen for vegetation transect analysis (Figure 8-M). Transects were located within the central portion of each stand and at the edge of the stand

FIGURE 8-M

VEGETATION SAMPLING LOCATIONS



SOURCE: STUDY DATA

a relatively large tree visible from an access road or pasture was marked and chosen as a "starting tree." The transect then ran from that tree through the middle of the stand along a predetermined compass direction. The first 100 feet of the transect were not sampled. Successive 100-foot sections were alternately sampled and passed over, except on Transects 7 and 8 which were small and sparsely vegetated. On Transect 7 all 100-foot sections were sampled except the first 50 feet, and on Transect 8 all 100-foot segments were surveyed except the first 100 feet. Measurements were made to 20 feet on either side of the 100-foot segments, giving an effective sampling area of 4000 square feet on each segment. All trees greater than 1 inch dbh were measured for their circumference at breast height (cbh). This was converted to dbh by dividing the cbh by pi (3.14).

Nomenclature followed Kurz and Godfrey (1962), and density and diversity were estimated by the "Wisconsin Method" (Curtis and McIntosh, 1951). Ground vegetation was quantified according to Daubenmire (1959) as modified by Crow (1971). A 0.20 x 0.50 m plot was sampled at fixed intervals along tree transects. Six coverage classes and midpoints of these classes were used in all computations. Species and their coverage classes within and overhanging the plot were recorded. In addition, the height of the tallest individual of each species within the frame was recorded. Heights and coverage classes were then averaged for each transect and frequency of occurrence was tabulated.

Plant Species Lists: Dominant plant species were listed at 99 locations on the site to aid in mapping and to develop the comprehensive species list.

Fauna: Prior to site visitations, faunal lists were compiled from recognized state and project area references (Peterson 1947, Carr and Goin 1955, Conant 1958, Hall and Kelson 1959, Burt and Grossenheider 1964, Robbins et al. 1966, Cochran and Goin 1970, Lowery 1974, Swift Chemical Co. 1974, CF Mining Corporation 1976, Stevenson 1976, Layne et al. 1977, Texas Instruments 1977b, Farmland Industries 1979). Experts from several state agencies were consulted to determine presence of certain species on site:

- Dr. William Hardy, Florida State Museum - Avifauna
- Mr. Paul Mohler, Florida Game and Fresh Water Fish Commission - Herpetofauna
- Mr. Robert Repenning, University of Florida - Avifauna

Evidence of species occurrence was collected during vegetation studies and on specific faunal searches. Faunal searches were qualitative, primarily using encounter techniques. Herpetofaunal field surveys were performed by log-rolling and debris raking. Stream surveys were conducted by pitchforking sandy bottoms while holding a sieve downstream. Permanent groundwater seeps were surveyed by raking through submerged and partly submerged debris and seining and dipnetting where appropriate. Surveys within marsh and swamp wetlands consisted primarily of dipnetting and minnow seining. In addition, direct observations of foraging individuals were made during other surveys. Specific bird and mammal surveys were not conducted, but sightings, calls, tracks, droppings, nests or burrows, and remains were recorded during all site visits.

Sensitive Species: Endangered, threatened and rare species and species of special concern were compiled from the following lists:

- Federal Register (January 17, 1979; 44(12): 3636-3654)
- Florida Game and Fresh Water Fish Commission (1979)
- Rare and Endangered Biota of Florida (1978)
- Florida Statute 581.185

The Federal Register was reviewed for critical habitats of sensitive species occurring on site. This review found that no critical habitat lies within the site boundaries.

The Florida Audubon Society, Florida Game and Fresh Water Fish Commission, and the Florida State Museum were contacted to determine sensitive species occurrences not recorded in the available literature. Specific habitats were examined where sensitive species were suspected or reported. Additional searches for sensitive species were conducted during other field work, particularly during vegetation mapping.

8.1.9.1.2 Aquatic Resources

Fish: Fish were sampled from Bowlegs Creek, several on-site tributaries, a freshwater marsh and a freshwater swamp (Figure 8-M). Eight locations were sampled using either seines, dipnets or a Goin dredge. Sampling was conducted for two hours at each location, except at Stephens Branch, where only one-half hour was required due to the small size of the stream. A representative series of each species at each station was preserved and deposited in the Florida State Museum, Gainesville, Florida. All fish collections were supervised by Dr. Carter Gilbert, Ichthyologist, Florida State Museum.

Benthic Macroinvertebrates: Benthic macroinvertebrates were collected in the Peace River, Bowlegs Creek and Gilshey Branch (Figure 8-D). The petite ponar grab was the standard sampling device for all systems. The device is quantitative, suited to generally sandy bottoms, and can be controlled on muck substrates as well. A standard surface area, represented by six petite ponar grabs, was collected for each of three replicate samples at each station. The six grabs were collected along a bank-to-bank diagonal transect passing through each replicate collection zone to insure that all habitat types (pools, riffles, root mats, littoral zones) were sampled. This process was repeated for each of the three replicate samples. This maximizes the chance of collecting all species present and allows statistical treatment of the data and characterization of the stream community.

Sampling was conducted during high flow and decreasing flow conditions (Table 8-21). Each sample was sieved in the field with a No. 30 mesh sieve and preserved with 70 percent ethanol containing rose bengal solution. In the laboratory, organisms were separated from substrate materials and identified to the lowest practical taxon with appropriate keys (Usinger 1956, Thompson 1968, Brinkhurst and Jamieson 1971, Beck 1976, Edmunds et al. 1976, Wiggins 1977). Identifications of unknown or unusual specimens were verified by the following:

- Mr. William Beck, Florida A & M University - Chironomids
- Dr. Minton Westfall, University of Florida - Odonates and other aquatic insects
- Dr. Michael Loden, Louisiana State University - Oligochaetes

Data analyses consisted of the following elements:

- species richness
- total number of organisms
- species diversity
- equitability
- Florida index

- percentage oligomixity
- faunal similarity
- faunal density

Species richness was calculated as the number of taxa per replicate and per station. Total number of organisms was tabulated for each replicate, and pooled totals were calculated for each station. Environmental parameters calculated for replicates with less than 100 specimens and those parameters calculated for pooled replicates with less than 100 specimens should be evaluated with caution (EPA, 1973). In most cases, pooled replicates contained more than 100 specimens.

Species diversity was estimated using the Shannon-Weaver index (Shannon and Weaver, 1963). Equitability was calculated as based upon MacArthur's broken stick model (MacArthur 1957, Lloyd and Ghelardi 1964, EPA 1973). The Florida index (Beck, 1954 and 1955) was calculated as a measure of ecological health of the benthic community, based on water quality and indicator organisms. Percentage oligomixity is defined as the percentage occurrence by a single taxon. Theoretically, a high percentage is indicative of a stressed environment (Thienemann, 1954). Faunal similarity between sampling periods and stations was calculated to provide indications of seasonal community assemblage shifts and differences between stations. Counts were standardized and Czekanowski's index was used for faunal similarity (Boesch, 1977). Faunal density was calculated as number of individuals/m^2.

8.1.9.2 Quality Assurance

Accepted, documented methods were used in the data collection program. Species area curves were calculated for adequacy of sampling for herbaceous and low shrubby vegetation. Unusual or taxonomically difficult plant specimens were sent to the University of Florida Herbarium for identification and/or verification. General vegetation and wetland maps were verified by aerial and ground surveys, and were reviewed by a third party. Benthic macroinvertebrate collections were made with six grabs per replicate to insure adequate sampling of the aquatic system. Identifications were made with taxonomic references and verified by comparison with an extensive macroinvertebrate reference collection. Unusual or unknown specimens were sent to recognized authorities for verification and/or identification. Authorities were contacted and herbarium searches were conducted to determine occurrence of rare and endangered species on the site to insure the adequacy of the literature and field surveys. Field observations of rare and endangered species were verified by third-party reviewers.

8.2 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

8.2.1 THE NO ACTION ALTERNATIVE

Under the no action alternative, terrestrial biological resources should remain basically the same as at present. Pasture would remain the major land use, and the vegetation on site would continue to be slowly altered by continued cattle foraging. Aquatic biological resources would be expected to remain the same as at present. However, natural succession would gradually modify habitats. Long-term changes in precipitation patterns could alter hydroperiods of wetlands and other aquatic habitats, resulting in possible shifts in plant and animal communities.

8.2.2 THE ACTION ALTERNATIVES INCLUDING THE PROPOSED ACTION

8.2.2.1 Mining Method Alternatives (See description DEIS 2.2)

Dragline (Mobil's Proposed Action): Biological resources on the South Fort Meade site would be affected by activities associated with the proposed action of dragline mining. These activities include clearing the land of vegetation, excavation of overburden and matrix, and construction of roads and other facilities to support the mining operations. Approximately 93 percent of the site (15,194 acres) would be disturbed over the life of the proposed mine. The disturbed and undisturbed acreages, by land use and cover type, are given in Table 8-22.

Land Communities: The seven major types of land communities occupy 86 percent (14,004 acres) of the total acreage of the site. Of this, 93.2 percent of the land communities (13,045 acres) will be disturbed during the life of the mine. The vegetation in these habitat types will be harvested and/or eliminated.

Type	Disturbed Acreage	Undisturbed Acreage	Percent Disturbed
Coniferous Forest	3,231	182	94.7
Hardwood Forest	1,140	664	63.1
Mixed Forest	121	5	96.0
Planted Forest	340	0	100.0
Cropland/Pastures	7,608	108	98.6
Clearcut	39	0	100.0
Citrus	566	0	100.0
Total	13,045	959	93.2

Sequential clearing of 50-acre parcels in front of each dragline would allow migration of larger and more motile fauna (such as the racoon, river otter, and birds) away from active mining areas to adjacent habitats. The adjacent habitat is probably at carrying capacity for populations of larger fauna, and the increases in population due to migration could result in more predation and disease and a decrease in reproduction. Populations could eventually stabilize with a resulting net loss in faunal resources. Some of the smaller and less motile species (such as amphibians, mice, and shrews) would be lost; however, many of these species are highly adaptable to habitats created during the mining process and reclamation.

Land-Water Interface Communities: Three major land-water interface communities occupy approximately 12.6 percent (2,054 acres) of the proposed mine site. During the life of the mine 93.6 percent (1,923 acres) will be disturbed.

Type	Disturbed Acreage	Undisturbed Acreages	Percent Disturbed
Wetland Coniferous Forest	3	75	3.8
Wetland Hardwood Forest	901	36	96.2
Non-forested, Vegetated Wetlands	1,019	21	98.0
Total	1,923	132	93.6

The preserved wetlands (132 acres) are primarily the large (75 acre) cypress dome on the eastern edge of the property and those wetlands within the buffer strips along the Peace River (450 feet each side) and Bowlegs Creek (300 feet each side).

Water Communities: Impacts on the aquatic ecosystems from dragline mining include eliminating 9 of the 12 acres (75 percent) of the ponds on site. Additionally, dragline mining will destroy aquatic habitat by eliminating 60,000 linear feet of tributary stream channel originating on the site. The Peace River and Bowlegs Creek would not be mined; however, alteration of stream flow would result from mining of adjacent areas. In sections of the on-site tributaries not subject to mining, Aquatic organisms may be affected by the mining of the rest of the tributary. The effects should be minimal since the protected areas are backwaters of the Peace River and Bowlegs Creek, the connection to which would allow fish and invertebrates the opportunity to move from the tributaries.

To gain access to mining parcels north of Bowlegs Creek, a dragline crossing would be located at an existing ford. Bowlegs Creek is scheduled to be crossed in 1999 and again in 2002 at the same ford. Woody vegetation in the corridor to the crossing would be cleared to about twice the width of the dragline (approximately 2 acres), and a culvert would be placed in the creek with earth backfilled around it. After each crossing, grass cover would be established to prevent erosion and runoff in the cleared corridor. After the second crossing in 2002, the culvert would be removed and the stream channel would be re-established. Tree species characteristic of wetlands would supplement the grass cover in the corridor.

Construction of the dragline crossing at Bowlegs Creek would affect downstream aquatic resources due to increased turbidity levels. High turbidity (suspended solids) effects on aquatic organisms result from sedimentation, reduction of light penetration and availability as a surface for growth of microorganisms. Increased turbidity would be temporary at the crossing area and the short-term duration (several days) should not present a major impact.

Migratory Wildlife and Game Species: Because of habitat degradation and absence of large open water bodies, few migratory or game species occur on the site. The area is not managed for hunting; the land is privately owned and hunting is restricted. There is no commercial fishing on site, although there is sport fishing on Bowlegs Creek and the Peace River. Creation of large open water areas for clay settling during waste disposal would provide short-term habitat for migratory waterfowl. Creation of wetlands in larger units (over 100 acres) or acreage blocks as a result of reclamation would benefit aquatic species. Terrestrial species would benefit from the creation of more mixed forest. The primary land use of the reclamation plan is agriculturally oriented with some benefits to terrestrial game species.

Agricultural and Forestry Resources: Existing agricultural resources, including pasture, cropland and citrus, would be virtually eliminated during mining of the South Fort Meade Mine site. Of the 8282 acres of agricultural land, 108 acres of improved pasture would be left undisturbed (Table 8-22). The 810 acres of row crops and 30 acres of field crops would be removed during mining. All of the 566 acres of citrus on site would be disturbed, including 446 acres of citrus designated by the Soil Conservation Service (SCS) as unique citrus areas.

Forestry resources (planted pine) presently occupy approximately 340 acres, representing the equivalent of 4,153 cords of wood. All planted pine acreage would be disturbed by mining. The wood would be harvested before the areas are mined.

Federal Rare and Endangered Species: No Federally protected plants were found on site. Regarding animal species, there is no designated critical habitat within the boundaries of the South Fort Meade Mine site. The U.S. Fish and Wildlife Service (December 18, 1980) supplied EPA with the following listing of species believed to be present in the area:

Bald Eagle - Endangered
Red-Cockaded Woodpecker - Endangered
Eastern Indigo Snake - Threatened
American Alligator - Threatened.

The southern bald eagle was reported to have been observed on site but the sighting could not be confirmed. However, an eagle nest was recently found approximately 1,800 feet outside the northeastern property boundary. The proposed mine site may be used by the bald eagle for foraging, especially during the feeding of the young. Although the lands preserved along the streams may provide nesting habitat, the proposed mining may eliminate potential feeding areas.

The red-cockaded woodpecker is not believed to exist on the site and consequently should not be adversely affected by the project.

The eastern indigo snake was observed primarily in the wooded strips along the Peace River and Bowlegs Creek. An effect of preserving a 450-foot buffer strip along the Peace River and a 300-foot buffer from each bank along Bowlegs Creek would be to minimize impacts on the indigo snake populations occurring in these areas. The individuals seen along the tributaries on the mine site would be disturbed by mining, but the slow pace of the land clearing and mining would provide an opportunity for the snakes to evacuate. The mining of the mesic environments and other habitats of potential occurrence of this species would result in destruction of available habitat for this species which could reduce populations.

Alligators inhabit Bowlegs Creek, the Peace River and some wetlands on the site. Bowlegs Creek, the Peace River and the lower lengths of their tributaries would be preserved as previously discussed. Many of the other small water areas would be mined. The total acreage of wetlands after mining would be slightly more than the existing and habitat for this species would be increased after reclamation. Ponds, ditches, pools and settling basins would provide temporary habitat during mining for the alligators. The land clearing operation would be gradual enough to allow the alligators to move out of the areas to be disturbed. The development of the proposed mine would not significantly affect the alligator population.

State Rare and Endangered Species: Twenty-four protected plants listed as endangered, threatened, or of special concern under Florida Statute 581.185

(Preservation of Native Flora of Florida) were observed on the proposed mine site. Their distribution on site is restricted primarily to the periphery and wooded strips along the Peace River, Bowlegs Creek, and portions of the tributaries which are within the designated preservation areas. Populations of species on other portions of the tributaries scheduled for mining and those occurring on scattered locations would be eliminated. The impacts of the regional populations of these species would be minimal, however, as none are presently in danger of elimination from the state. Animal species classified as endangered, threatened, or of special concern by the Florida Game and Fresh Water Fish Commission are listed below.

Wood Stork - Endangered
Florida Sandhill Crane - Threatened
Sherman's Fox Squirrel - Special Concern
Gopher Tortoise - Special Concern
Florida Burrowing Owl - Special Concern
Little Blue Heron - Special Concern
Snowy Egret - Special Concern
Louisiana Heron - Special Concern.

The wood stork habitat on site is small in extent and of poor quality. This species is not characteristic to the site and, therefore, should not be affected by the development of the proposed mine.

The Florida sandhill crane was observed at four locations on the mine site. They are thought to be residents since the site contains pasture and freshwater marsh, their preferred habitat. Mining would destroy their preferred habitat; however, reclamation would restore both freshwater marsh and pasture.

Two Sherman's fox squirrels were observed on site in uncharacteristic habitat. The small size and poor quality of longleaf pine habitats on site suggest that the fox squirrel population is small. Mining would eliminate this species' habitat on the project site.

The gopher tortoise was observed on site and occurs in habitats on xeric, sandy soils; however, much of this land is now in pasture and there are only a very few active burrows left. Mining would eliminate this species from the site; however, it is not expected that mining would have a significant effect on the gopher tortoise populations of the region.

The Florida burrowing owl was observed on the proposed mine site. Almost all pastures on site with dry, sandy soil have active owl burrows. In one pasture 12 active owl burrows were found. Mining would eliminate almost all (98.6 percent) of the pasture/cropland on site. Reclamation would result in restoration of pasture; however, soils may not be suitable for nesting of this species.

The little blue heron, snowy egret, and Louisiana heron were observed on the proposed mine site. All sightings included a low number of individuals and no rookery areas were found. Their wetland habitats on the site are either small or of poor quality, limiting viable population levels of these species on site. Mining will eliminate 93.6 percent of the wetland communities on site. Since there are no known nesting colonies on site, mining would have little impact on regional populations of these species.

Wetlands: Site-specific conditions were used to assist in evaluating the functional value of the wetlands present on the site. The study, "South Fort Meade Mine Tributary Functional Analysis to Support an Assignment of EPA Wetland Categories", indicated that the interior wetland units have minimal aquatic system value and regional significance. Wetland areas on the property were classified as either Category 1 (preserve and protect), Category 2 (mine and restore with equivalent acreage) or Category 3 (mine with no restoration to wetlands).

Construction of the proposed mine would result in the loss and protection of the following acreages of each of the wetland categories.

	Acres Existing	Acres Disturbed	Acres Protected	Percent Protected
Category 1	84	0	84	100
Category 2	1,601	1,553	48	3
Category 3	370	370	0	0
Totals	2,055	1,923	132	6

Approximately 1,923 acres designated as wetlands (94 percent of total wetland acreage) wold be eliminated by mining (Table 8-22). The preserved wetlands (132 acres) are primarily the large (75 acre) cypress dome on the eastern edge of the property and wetland areas within buffer strips along the Peace River (450 feet each side) and Bowlegs Creek (300 feet each side).

Bucket Wheel: The bucket wheel mining method would disturb the land surface in much the same way as the dragline method. Impacts on the biological resources resulting from bucketwheel mining would be essentially the same as those described for dragline mining.

Dredge: The dredge mining method requires clearing large tracts of land to provide dredge basins, resulting in a larger habitat loss at one time than the dragline mining method. Larger amounts of aquatic habitat are created, but the dredge basin pools are limited in their usefulness for many aquatic species, with the exception of migratory waterfowl due to small litoral zones. The impacts associated with dragline mining would also be expected with dredge mining. Additional impacts associated with dredging could result from dredge basin dike failure and subsequent release of turbid water into nearby surface water. This could adversely affect aquatic organisms by increasing suspended solids levels and other pollutants. Crossing Bowlegs Creek would be accomplished by transportation of the dredge along existing roads with minimal impact on the site's biological resources.

8.2.2.2 Matrix Transfer Alternatives (See description DEIS 2.3)

Pipeline (Mobil's Proposed Action): A pipeline method of transfer requires clearing corridors (approximately 12 feet wide) from the mining area to the plant facilities. Impacts resulting from clearing, construction and maintenance include habitat destruction, disruption or isolation of habitat units cut by the corridor, and altered migration and dispersal patterns of fauna. These impacts would probably be short-term because the pipeline corridor locations are changed as mining proceeds, and are usually maintained on disturbed lands which would require minimal clearing.

Mining on the north side of Bowlegs Creek would require a matrix slurry pipeline stream crossing of Bowlegs Creek during a four-year period of the mine life. If a break or leak occurred in the transfer line at the stream crossing, suspended solids, nutrients, sediment, and other contaminants would be increased and would damage aquatic and wetland ecosystems for a short time until corrective clean-up action were taken. The use of valves and double-walled pipe as described in Mobil's proposed action would minimize the potential for a spill occurrence at the stream crossing.

Conveyor Belt: Impacts resulting from corridor routing of the conveyor belt system would be similar to those described for the pipeline system. Spills from the conveyor system would be more confined due to the solid nature of the material and would have less effect on terrestrial and aquatic ecosystems.

Truck: Roads for truck transfer of the matrix would have impacts similar to those discussed for the pipeline system, although the corridor (road) would be larger and more permanent than that for the pipeline. Although the potential for spills or leaks is less for this matrix transfer alternative, truck transfer would result in increased noise, fugitive dust and truck emissions, all of which could disrupt wildlife in the immediately adjacent area.

8.2.2.3 Waste Disposal Alternatives (See description DEIS 2.5)

Conventional Clay Settling Case (Mobil's Proposed Action): The landform acreages for each waste disposal case are given in Table 8.2-3. Above-grade settling basins are the predominate landform in the conventional case. A primary concern with above-grade settling basins is the potential for dike failure. In the event of a failure, large volumes of clay could be discharged into Bowlegs Creek and/or the Peace River, increasing turbidity, destroying natural biological communities, depositing sediments, and raising the concentrations of sulfates, fluorides, and total dissolved solids. The physical action of a spill would destroy vegetation and fauna at the spill site, while downstream aquatic organisms could be lost due to water quality degradation and excessive sedimentation. Studies of spills (Ware, 1969) indicate that approximately 90 percent of fish and most of the macroinvertebrates (except oligochaetes and chironomid larvae) in the spill zone were killed by blanketing from sediments. However, both investigators judged stream recovery as rapid. Terrestrial ecosystems within a spill zone would be damaged by flooding and destruction of ground cover and by the loss of less motile fauna (such as amphibians, mice and shrews) which would be smothered by the clay wastes.

During the life of the mine, approximately 8,170 acres (Table 8-23) of above-grade clay settling basins would be constructed with dike heights ranging from 25 to 45 feet and averaging 38.7 feet. The highest probability for a dike failure would be when the greatest amount of active above-grade settling acreage is in service. For the conventional clay settling case this occurs in mine years 12 through 14 when five basins (CS-4, CS-5, CS-6, CS-7 and CS-8) covering 2,760 acres are all active, operating in a flow-through settling mode. Should a dam failure happen at this time, most of the clays released would probably flow into Bowlegs Creek or the Peace River because of the natural topography of the site. It is doubtful that any off-site property would be affected except for the roadways that pass through the site. The primary effect would be on the on-site and downstream sections of the Peace River and Bowlegs Creek. Smaller spills could occur from other isolated clay settling areas. The primary effect would still be the destruction of the biota in the Peace River or Bowlegs Creek.

The technology used to construct the settling basin dikes has improved substantially during the past decade, reducing the likelihood of a dike failure. Thorough investigations of foundation and soil conditions at the location of the proposed dikes would be conducted on the South Fort Meade site prior to design and construction. The dikes would be continuously inspected and monitored during the active life of the settling basins. Mobil would comply with the regulations for design, construction and maintenance of earthen dams established by the Florida Department of Environmental Regulation (FAC Chapter 17-9).

The active settling areas would provide interim aquatic habitats. These areas would support common marsh species as volunteer plants invade them and would provide food sources for wildlife.

Sand/Clay Cap Case: The sand/clay cap waste disposal case has dike configurations similar to those of the conventional clay settling case; however, the average dike height is decreased two feet. Flow through settling cannot be practiced with this waste disposal case; therefore, the amount of active above-grade settling acreage is reduced. Basin CS-3 would be used during the life of the mine as a dredge basin and would be filled and emptied several times during the mining activities. The greatest amount of active above-grade settling occurs in mine years 17 through 19 when CS-3 and CS-10, with a maximum area of 1,860 acres, are active.

The probability for a dike failure occurring is decreased for the sand/clay cap waste disposal case compared to the proposed action because of the reduced active settling acreage (less than 1,860 acres compared to 2,790 acres). Should a spill event occur, the effect on biological resources would be similar to that described for the proposed action except that the volume of clay that could potentially spill would be reduced by 21 percent for the sand/clay cap waste disposal case compared to the conventional clay settling case. This reduction results from the lower average clay fill height with the sand/clay cap case (27 feet versus 34 feet).

Interim aquatic habitat provided by clay settling areas would be less for the sand/clay cap case than for the proposed conventional case bacause of the reduced active settling acreage.

Sand/Clay Mix Case: The sand/clay mix waste disposal case has 4,827 acres of above-grade clay settling basins (with dike heights from 40 to 48 feet), and 3,352 acres of above-grade sand/clay mix basins (with dike heights from 20 to 37 feet) (Table 8-23). The 4,827 acres of above-grade clay settling basins would be operated in a manner comparable to the sand/clay cap case and could not utilize flow through settling since these areas will be dewatered quickly in order to cap them with sand/clay mix. Two dredge basins would be constructed to provide clay for sand/clay cap material as well as sand/clay mix for the 3,352 acres of mix basins. The greatest amount of active above-grade settling acreage would be in mine years 10 through 11 when CS-1, CS-2, CS-3, CS-4 and CS-5, with a maximum area of 2,450 acres are active. Therefore, the potential for a dike failure occurring is greater than the sand/clay cap case but less than the conventional clay settling case.

The sand/clay mix case has two types of above-grade basins: sand/clay mix and conventional clay settling. The sand/clay mix material would consolidate more rapidly and would have higher density than the clay wastes impounded separately. This increase in density and consolidation would result in a decrease in flow characteristics of the mix material should a dike failure occur from one of the mix basins. Therefore, the volume of a sand/clay mix spill would be less than that expected from a clay settling basin spill. If a dike failure occurred from one of the clay settling basins the effect would depend on the quantity of material released but would be similar to that described under the conventional clay settling case.

The sand/clay mix case would have less active settling acreage resulting in less interim aquatic habitat than would be available with the proposed conventional disposal case.

Overburden Mix Case: The configuration, size and active settling acreage of above-grade basins with the overburden mix waste disposal case are similar to the sand/clay mix case; however, the extent of sand/clay mix impoundments would be increased to 7,670 acres. The average dam height would be 38 feet. The potential for a dike failure and resultant effect on surface water streams would be comparable to those described for the sand/clay mix basins under the sand/clay mix case.

8.2.2.4 Reclamation Alternatives (See description DEIS 2.6)

Conventional Clay Settling Plan (Mobil's Proposed Action): Mobil's proposed reclamation plan for the 15,194 acres disturbed by mining would result in the following: improved pasture (11,413 acres) developed on above-grade settling areas and sand tailings fill areas with overburden cap; upland mixed forest (1,271 acres), planted pine (453 acres) and forested stream channel (277 acres) developed in sand tailings fill areas with overburden cap; freshwater swamp (478 acres) developed in above-grade clay settling areas, and freshwater marsh (1,302 acres) developed in below-grade clay settling areas capped with overburden. The reclamation acreages, by land use and cover type, are shown in Table 8-24 for each reclamation case.

With completion of reclamation, the total wetland acreage would be approximately 93 percent of that existing on the site; the combined forested stream channel acreage and wetland acreage would exceed the existing wetland acreage by approximately seven percent (Table 8-24). However, there would be a shift in the proportion of wetland type from freshwater swamp toward freshwater marshes. Specifically, reclamation would decrease freshwater swamp acreage by 426 acres (from 1,015 to 589) and increase freshwater marsh acreage by 283 acres (from 1,040 to 1,323). Reclaimed upland mixed forests would serve to expand the forested zones along the Peace River and Bowlegs Creek and provide dense forest stands. Final land use and cover for the conventional reclamation case would be predominately agriculture (Table 8-24), which is consistent with the present land use on the site. More specifically, land use is proposed as improved pasture with no provision for row crops, field crops, or citrus. Planted pine acreage would be increased from 339 to 453 acres.

The conventional settling case does not favor establishment of trees except in sand tailings, overburden, and cap areas. Waste clay disposal areas (no cap or mix) are best suited to perennial forage crops or pasture. The above-grade clay waste areas capped with sand would be reclaimed as pasture, but would also contain a mixture of hardwood and coniferous tree species. All reforestation would be done with a mixture of native tree species such as longleaf pine, live oak, and dogwood on well-drained sites and water oak, sweet gum, and slash pine on wetter sites. Planting density would be 400 trees/acre for upland reforestation.

At various locations thickets would be planted to provide escape cover for animals and generally increase diversity of plant cover. Stream channel reclamation would be done in sand tailings or overburden fill areas, and a normal water level channel and/or associated floodplain created. Shallow pools would be maintained in the created stream channels to provide permanent water supply for wildlife.

Short-term adverse reclamation impacts would result from recontouring, vegetation planting and construction of stream channels. Capping of settling areas would result in the loss of vegetation and wildlife established on clay settling and tailings fill areas. Construction activities would produce increased noise levels, fugitive dust and potential erosion problems, possibly affecting adjacent protected areas on Bowlegs Creek and the Peace River. Removal of native volunteer vegetation prior to replanting according to the desired vegetation schemes would result in the loss of large areas of interim habitat. However, these impacts are minor in terms of long-term reclamation goals.

Reconstruction of stream channels to approximate former drainage patterns on site could potentially create turbidity and sedimentation in the Peace River and Bowlegs Creek. The proposed action would minimize this impact by allowing complete vegetation to be established in the channels for filtering and reducing sediment loads and turbidity before connection with the downstream channel. Additionally, establishment of shallow depressions, where drainage would exist in the reclaimed waste disposal areas, would provide a filtering effect once vegetation is established. Establishment of streams or tributaries would provide drainage for surface water runoff from the reclaimed landforms, as well as avenues of dispersal for animals and detrital materials.

Sand/Clay Cap Plan: The sand/clay cap reclamation plan would reclaim the 15,194 acre disturbed area as follows: improved pasture (11,003 acres) would be developed in above-grade clay settling areas capped with 4:1 sand/clay mix and sand tailings fill areas with an overburden cap; upland mixed forest (1,451 acres), planted pine (536 acres), and forested stream channel (279 acres) would be developed in sand/tailings fill areas with an overburden cap; freshwater swamp (504 acres) would be developed in above-grade clay settling areas; and freshwater marsh (1,421 acres) would be developed in below-grade clay settling areas capped with overburden (Table 8-24).

However, the areas capped with a sand/clay mix (4:1 ratio) are less limited in their agricultural potential than either the uncapped conventional clay settling areas or the 2:1 sand/clay mix areas. That is to say, although the proposed land use in each case is improved pasture, the surface soils composed of the 4:1 sand/clay mix should also allow the planting of field and row crops. More wetland acreage (8 percent) is proposed for this reclamation plan than for the conventional clay settling plan. Additionally, more upland forested areas are proposed for reclamation due to the suitability for shrub and tree planting of capped clays versus open or no cap on waste clay disposal sites. This would aid wildlife by committing more acreage to suitable habitat. Reforestation and revegetation would be the same as for the conventional plan. Stream channel creation would also be the same as for the conventional plan except that there would be less alteration of drainage areas from existing patterns.

Sand/Clay Mix Plan: The sand/clay mix reclamation plan would reclaim the 15,194 acre disturbed area as follows: improved pasture (10,313 acres) would be developed in above-grade sand/clay mix (2:1) areas, clay settling areas, and sand tailing fill areas capped with overburden; upland mixed forest (1,826 acres), planted pine (431 acres) and forested stream channel (263 acres) would be developed in sand tailings fill areas with an overburden cap; freshwater swamp (746 acres) would be developed in above-grade sand/clay mix (2:1) areas, clay settling areas and below-grade sand/clay mix (2:1) areas; and freshwater marsh (1,615 acres) would be developed in below-grade clay settling areas capped with overburden (Table 8-24).

Soils would be more suitable for planting of tree species in this plan than in the conventional plan. The sand/clay mix reclamation plan would result in the reclamation of 2,495 acres of upland hardwood and mixed forest and 2,361 acres of wetlands. This would result in more wildlife habitat for invading and recolonizing animal species than would be available as a result of the two previously discussed reclamation plans.

Overburden/Clay Mix Plan: The overburden/clay mix reclamation plan would reclaim the 15,194 acre disturbed area essentially the same as the sand/clay mix plan. The reclamation acreages by land use and cover are shown in Table 8-24. The major difference in impacts on biological resources between the overburden/clay mix and the sand/clay mix reclamation plans is the potential for additional tree planting. The conversion of the 1,642 acres of clay surface soils to sand/clay mix soils creates the potential for additional forest areas by planting or by natural colonization.

8.2.2.5 Water Source Alternatives (See description DEIS 2.7)

Groundwater (Mobil's Proposed Action): No impact on the biological resources is anticipated from the use of groundwater pumped from the Floridan Aquifer for the water source. Streams, wetlands, and other surface water resources would not be affected by this action.

Surface Water: This alternative would require impoundment of portions of Bowlegs Creek, reducing and possibly eliminating stream flow and materials contribution from Bowlegs Creek to the Peace River. The floodplain characteristics of Bowlegs Creek to the Peace River and downstream of the impoundment would be altered. Impoundment would require clearing of preserved wetlands and stream buffer zones for reservoir construction. The surface water alternative would also result in adverse impacts on the ecological communities of Bowlegs Creek by eliminating the lotic biological resources now associated with it. However, an area of open water habitat would be created resulting in a more stable lentic biological community.

8.2.2.6 Plant Siting Alternatives (See description DEIS 2.8)

Gilshey Branch (Mobil's Proposed Action): The biological impacts of locating the beneficiation plant on the flatlands between Gurr Run and Gilshey Branch would be confined to removal of the vegetation in the area of construction. The proposed plant location is in an area now utilized for pasture with minimal plant and animal value; therefore, no significant effects on wildlife are anticipated from this action.

Other On-Site Locations: Locating the plant near preserved areas on the property would increase the potential for adverse impacts, such as dust, noise, and spillage, on the biological systems. Other on-site locations could have similar impacts to the proposed action if they were centrally located and had a pasture cover.

8.2.2.7 Water Discharge Alternatives (See description DEIS 2.9)

Peace River (Mobil's Proposed Action): Discharge from the clear water pool would occur primarily during extreme rainfall events. Discharge to the Peace

River at average flow could adversely affect aquatic biological resources downstream of the discharge point since suspended solids loads at maximum discharge may damage aquatic organisms. However, discharge should occur only during extreme rainfall events when increased dilution would occur due to the high flow condition in the receiving stream.

Bowlegs Creek: Flows at maximum discharge would be eight times the annual mean flow of Bowlegs Creek, resulting in very little potential for dilution of discharge constituents. The excessive flows could increase turbidity levels and initiate scouring, both of which would adversely affect aquatic life in downstream portions of the creek.

8.2.2.8 Product Transport Alternatives (See description DEIS 2.10)

Railroad (Mobil's Proposed Action): Land clearing, construction and continual use of the railroad spur would disturb natural communities along the proposed route and would disrupt local animal migration and dispersal patterns in habitats adjacent to the route. Noise associated with this transport process would also adversely affect wildlife in adjacent habitats. The proposed route requires a crossing of the Peace River. Construction of a trestle or bridge would temporarily affect aquatic biological communities of the Peace River as a result of sedimentation and turbidity. Construction of bridge or trestle approaches would affect the floodplain vegetation, but impacts should be minimal as there are no extensive floodplain wetlands associated with the Peace River at the railroad crossing site.

Truck: Existing road systems would be used to transport products by truck; therefore, no further impacts from corridor routings are anticipated. Fugitive dust and noise would increase due to increased vehicular use of the road systems, resulting in adverse impacts to vegetation resources and disturbance of wildlife in adjacent habitats.

8.3 REFERENCES

Bayley, S. and H.T. Odum. 1973. Energy Evaluation of Water Management Alternatives in the Upper St. Johns River Basin of Florida. EPA, Region IV, Atlanta.

Beck, W.M., Jr. 1954. Studies in Stream Pollution Biology. I. A Simplified Ecological Classification of Organisms. Q. J. Fla. Acad. Sci. 17(4):211-227.

Beck, W.M., Jr. 1955. Suggested Method for Reporting Biotic Data. Sewage and Industrial Wastes 27(10):1193-1197.

Beck, W.M., Jr. 1976. Biology of the Larval Chironomids. Fla. St. Dept. Envir. Reg., Tech. Ser. 2(1):1-58.

Beckenbach, J.R. 1973. Principal Soil Areas of Florida, A Supplement to the General Soil Map. Univ. Fla. Inst. Food & Ag. Sci., Ag. Exp. Sta., in Cooperation with USDA, Bull. 717.

Beckwith, S.L. 1976. Chinsegut Hill - McCarty Woods, Hernando Co., Florida. Q. J. Fla. Acad. Sci. 30:250-268.

Boesch, D.F. 1977. Application of Numerical Classification in Ecological Investigations of Water Pollution. U.S. EPA, Corvallis Env. Res. Lab, Corvallis, Or. EPA-600/3-77-033.

Brinkhurst, R.O. and B.G.M. Jamieson. 1971. Aquatic Oligochaeta of the World. University of Toronto Press, Toronto, Canada.

Brown, H.P. 1972. Biota of Freshwater Ecosystems, Identification Manual No. 6, Aquatic Dryopoid Beetles (Coleoptera) of the United States. U.S. Gov. Printing Office, Washington, D.C.

Brown, L.N. 1978. Florida Weasel. In Rare and Endangered Biota of Florida. v. 1. Mammals. P.C.H. Pritchard and J.N. Layne [Eds.] University Presses of Florida, Gainesville.

Burt, W.H. and R.P. Grossenhieder. 1964. A Field Guide to the Mammals of North America. 2nd ed. Houghton Mifflin Co., Boston, Ma.

Byers, C.F. 1930. A Contribution to the Knowledge of Florida Odonata. University of Fla. Publ., Biol. Sci. Ser. v. 1, No. 1.

Cairns. J., Jr. and K.L. Dickson. 1971. A Simple Method for the Biological Assessment of Waste Discharge on the Aquatic Bottom Dwelling Organisms. J. Water Poll. Con. Fed. 43(5):755-772.

Campbell, H.W. 1978. Short-Tailed Snake. In Rare and Endangered Biota of Florida. v. 3. Amphibians and Reptiles. P.C.H. Pritchard and R.W. McDiarmid [Eds.] University Presses of Florida, Gainesville.

Carr, A. and C.J. Goin. 1955. Guide to the Reptiles, Amphibians and Freshwater Fishes of Florida. University Presses of Florida, Gainesville.

C.F. Mining Corporation. 1976. Application for Development Approval. C.F. Mining Corporation, Hardee Phosphate Complex, A Development of Regional Impact. v. 1. Terrestrial. Prepared by Dames and Moore.

Chapman. H.H. 1932. Is the Longleaf Type a Climax? Ecology 13:328-334.

Clewell, A.F. 1971. The Vegetation of the Apalachicola National Forest: An Ecological Perspective. USDA Forest Serv., Tallahassee.

Cochran, D. M. and C. J. Goin. 1970. The New Field Book of Reptiles and

Amphibians. G.P. Putman's Sons, New York, N.Y.

Conant, R. 1958. A Field Guide to Reptiles and Amphibians of the United States and Canada East of the 100th Meridian. Houghton Mifflin Co. Boston, Ma.

Cooke, C. W. 1945. Geology of Florida. Fla. Geol. Surv. Bull. 29.

Courtenay, W.R., Jr., H. F. Sahlman, W. W. Miley II, and D. J. Herrema. 1974. Exotic Fishes in Fresh and Brackish Waters of Florida. Bio. Cons. 6(4):292-302.

Cowardin, L.M., V. Carter, F.C. Golef, and E.T. LaRue. 1977. Classification of Wetlands and Deepwater Habitats of the United States. Operational Draft. U.S. Fish and Wildlife Service.

Crossman, J.S., R.L. Laesler, and J. Cairns, Jr. 1974. The Use of Cluster Analysis in the Assessment of Spills of Hazardous Materials. Amer. Midl. Nat. 92(1):94-114.

Crow, J.H. 1971. Earthquake-Initiated Changes in the Nesting Habitat of the Dusky Canada Goose. In The Great Alaska Earthquake of 1964: Biology. The Committee on the Alaska Earthquake of the Division of Earth Sciences. Nat. Res. Council. Nat. Acad. of Sci. Washington, D.C. Publ. 1604.

Curtis, J.T. and R.P. McIntosh. 1951. The Upland Forest Continuum in the Prairie-Forest Border Region of Wisconsin. Ecology 32:476-496.

Dames and Moore. 1975. Hydrologic Assessment of the Alafia and Little Manatee River Basins. S.W. Fl. Water Mgmt. Dist., Alafia River Basin Bd.

Daubenmire, R. 1959. A Canopy Coverage Method of Vegetation Analysis. Northwest Sci. 33:43-64.

Davis, J.H. 1943. The Natural Features of Southern Florida, Especially the Vegetation and the Everglades. Fla. Geo. Surv. Bull. 24.

Davis, J.H. 1967. General Map of Natural Vegetation of Florida. Agr. Exp. Sta., Inst. Food Agr. Sci., Univ. of Florida.

Dills, C.G. and D.T. Rodgers. 1972. Aquatic-Biotic Community Structure as an Indicator of Pollution. Geol. Surv. Ala. Circ. 80.

Edmunds, G.F., Jr., S.L. Jensen, and L. Berner. 1976. The Mayflies of North and Central America. Univ. Minn. Press. Minneapolis, Mn.

Farmland Industries, Inc. 1979. A Development of Regional Impact Application for Development Approval for a Phosphate Mining and Chemical Fertilizer Complex, Hardee County, Fl.

Florida Game and Fresh Water Fish Commission. 1978. Rules of the Florida Game and Fresh Water Fish Commission. Tallahassee, Fl.

Garren, K. H. 1943. Effects of Fire on Vegetation of the Southeastern United States. Bot. Rev. 9:617-654.

Gilbert, C.R. (1977). Freshwater Fishes of Southwestern Peninsular Florida. Unpubl. MS.

Hall, E.R. and K.R. Kelson. 1959. The Mammals of North America. 2 Vol. The Ronald Press, New York, N.Y.

Harris, L.D., L.D. White, J.E. Johnston, and D.G. Milchunas. 1974. Impact of Forest Plantations on North Florida Wildlife Habitat. Proc. Ann. Con. Southeast Assoc. Game and Fish Comm. 28:659-667.

Hynes, H.B.N. 1970. The Ecology of Running Water. Univ. Toronto Press. Toronto, Canada.

Kolb, W.O., H. Pardin, A. Spielberger, G. Manning, and K. Maw. 1976. The Florida Land Use and Cover Classification System. A Technical Report. Fl. Dept. Admin., Div. St. Plan., Bur. Compreh. Plan.

Kuchler, S.W. 1964. Manual to Accompany the Map Potential Natural Vegetation of the Conterminous United States. Amer. Geog. Soc. Spec. Publ. No. 36.

Kurz, H. and R.K. R.K. Godrey. 1962. Trees of Northern Florida. University Presses of Florida, Gainesville.

Laessle, A. M. 1942. The Plants of the Welaka Area. Univ. Fla. Bio. Sci. Ser. 4(1):1-109.

Laessle, A. M. and O. E. Frey. 1956. The Origin and Successional Relationships of Sandhill Vegetation and Sand Pine Scrub. Ecol. Monog. 28:361-387.

Lanquist, E. 1953. A Biological Survey of the Peace River, Florida. M.S. Thesis. University of Florida, Gainesville.

Layne, J.N., J.A. Stallcup, G.E. Woolfenden, M.N. McCauley, and D.J. Worley. 1977. Fish and Wildlife Inventory of the Seven-County Region Included in the Central Florida Phosphate Industry Areawide Environmental Impact Study. Archbold Biological Station, Lake Placid, Fl.

Little, E.L., Jr. 1979. Checklist of United States Trees (Native and Naturalized). USDA Forest Service Agricultural Handbook No. 541.

Lloyd, M. and R.J. Ghelardi. 1964. A Table for Calculating the Equitability Component of Species Diversity. J. Anim. Ecol. 33:217-225.

Long, R.W. and O. Lakela. 1971. A Flora of Tropical Florida. Univ. Miami Press, Coral Gables, Fl.

Lowery, G. H., Jr. 1974. Louisiana Birds (3rd Ed.). Louisiana State Univ.Press, Baton Rouge.

MacArthur, R.H. 1957. On the Relative Abundance of Bird Species. Proc. Nat. Acad. Sci. 43:293-295.

McNulty, J.K. 1961. Ecological Effects of Sewage Pollution in Biscayne Bay, Florida. Bull. Mar. Sci. 11(3):394-447.

Mississippi Chemical Corp. 1976. Development of Regional Impact Application for Development Approval. Hardee County, Florida.

Monk, C.D. 1965. Southern Mixed Hardwood Forest of North-Central Florida. Ecol. Mono. 35(4):335-354.

Monk, C.D. 1966. An Ecological Study of Hardwood Swamps in North-Central Florida. Ecology 47(4):649-654.

Monk, C.D. 1968. Successional and Environmental Relationships of the Forest Vegetation of North-Central Florida. Amer. Midland Nat. 79(2):441-457.

Neill, W.T. 1957. Historical Biogeography of Present-Day Florida. Bull. Fla. State Mus. 2(7):175-220.

Nesbitt, S.R. 1978. Limpkin. In Rare and Endangered Biota of Florida. v. 2. Birds. P.C.H. Pritchard and H.W. Kale [Eds.] University Presses of Florida, Gainesville.

Ogden, J.C. 1978. Osprey. In Rare and Endangered Biota of Florida. v. 2. Birds. P.C.H. Pritchard and H.W. Kale [Eds.] University Presses of Florida, Gainesville.

Oliver, D.R., D. McClymont, and M.E. Roussel. 1978. A Key to Some Larvae of Chironomidae (Diptera) from the Mackenzie and Porcupine River Watersheds. Fish and Mar. Serv. Tech. Rept. No. 791. Ottawa, Ontario, Canada.

Palmer, C.M. and R.L. Lewis, [Eds.] 1977. Algae and Water Pollution. U.S. EPA, Municipal Research Laboratory. Office of Research and Development. Cincinnati, Oh. EPA-600/9-77-036.

Parrish, F.K. [Ed.] 1975. Keys to Water Quality Indicative Organisms (Southeastern United States). U.S. EPA, EMSL, Aq. Biol. Soc., Cincinnati, Oh.

Penfound, W.T. 1952. Southern Swamps and Marshes. Bot. Rev. 18:413-446.

Peterson, R.T. 1947. A Field Guide to the Birds (2nd Ed.). Houghton Mifflin Co., Boston, Ma.

Pritchard, P.C.H. and C.R. Gilbert [Eds.] 1978. Rare and Endangered Biota of Florida. v. 4. Fishes. University Presses of Florida, Gainesville.

Pritchard, P.C.H. and H.W. Kale [Eds.]. 1978. Rare and Endangered Biota of Florida. v. 2. Birds. University Presses of Florida, Gainesville.
Pritchard, P.C.H. and J.N. Layne [Eds.]. 1978. Rare and Endangered Biota of Florida. v. 1. Mammals. University Presses of Florida, Gainesville.

Pritchard, P.C.H. and R.W. McDiarmid [Eds.]. 1978. Rare and Endangered Biota of Florida. v. 3. Amphibians and Reptiles. University Presses of Florida, Gainesville.

Pritchard. P.C.H. and D.B. Ward [Eds.]. 1978. Rare and Endangered Biota of Florida. v. 5. Plants. University Presses of Florida, Gainesville.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1964. Manual of the Vascular Flora of the Carolinas. Univ. North Carolina Press, Chapel Hill.

Reppert, R.T., W. Sigleo, E. Stakhiv, L. Messman, and D. Meyers. 1979. Wetland Values: Concepts and Methods for Wetland Evaluation. IWR Research Report 79-R1. U.S. Army Engr. Inst. for Water. Res. Kingman Bld., Ft. Belvoir, Va.

Robbins, C.S., B. Brown, and H.S. Zinn. 1966. Birds of North America. Golden Press, New York. 340 pp.

Saether, O.A. 1977. Taxonomic Studies on Chironomidae: Nanocladius, Pseudochironomus, and the Harnischia complex. Bull. Fish Res. Can. No. 196.

Shannon, C.E. and W. Weaver. 1963. The Mathematical Theory of Communication. Univ. Illinois Press, Urbana.

Smith, R.L. 1966. Ecology and Field Biology. Harper and Row Publ., Inc. New York, N.Y.

Stevenson, H.M. 1976. Vertebrates of Florida. University Presses of Florida, Gainesville.

Swift Chemical Co. 1974. A Natural Resources Inventory and Ecological Analysis for a Development of Regional Impact (Phosphate Mine) in Manatee County, Fl. Report Submitted to Swift (Estech) Chemical Co., Bartow, Fl. Prepared by Ecoimpact, Inc.

Teas, H. J. 1976. Wetland Vegetation Types of Penisular Florida. Univ. Miami Press, Miami.

Texas Instruments, Inc. 1977a. Central Florida Phosphate Industry Areawide Impact Assessment Program. v. 5. Water. Sect. 2. Aquatic Biota. Texas Instruments, Dallas, Tx.

Texas Instruments, Inc. 1977b. Central Florida Phosphate Industry Areawide Impact Assessment Program. v. 6. Land. Sect. 5. Terrestrial Biota. Texas Instruments, Dallas, Tx.

Thienemann, A. 1954. Ein Drittes Biozonistic Hes Grundprinzie. Arch. Hydrobive 49(3):431-432.

Thompson, F.G. 1968. The Aquatic Snails of the Family Hydrobiidae of Peninsular Florida. University Presses of Florida, Gainesville.

Thompson, R.B. [Ed]. 1976. Florida Statistical Abstract, 1976. Univ. Presses of Florida, Gainesville.

U.S. Army Corps of Engineers. 1978. Preliminary Guide to Wetlands of Peninsular Florida. Major Associations and Communities Identified. Technical Report Y-28-2. Environmental Effects Lab., Vicksburg, Miss.

U.S. EPA. 1973. Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents. Office of Research and Development, Cincinnati, Oh. EPA-670/4-73-001.

U.S. EPA. 1977. Algae and Water Pollution. Municipal Environmental Research Laboratory. Office of Research and Development, Cincinnati, Oh. EPA-600/9-77-036.

U.S. EPA. 1978. Central Florida Phosphate Industry, Areawide Impact Assessment Program. U.S. EPA, Region IV, Atlanta, Ga. EPA 904/9-78-006.

U.S. EPA. 1979. Environmental Impact Statement. Estech General Chemicals Corps., Duette Mine, Manatee County, Fl. U.S. EPA, Region IV, Atlanta, Ga. EPA 904/9-79-044.

U.S. Federal Register. Endangered and Threatened Wildlife and Plants. Vol. 44. No. 12. January 17, 1979. Chapter I, Part 17. pp. 3636-3654.

U.S. Fish and Wildlife Service 1976. Endangered and Threatened Wildlife and Plants: Proposed Endangered Status for Some 1700 U.S. Vascular Plant Taxa. Federal Register 4(117):24524-24572.

Usinger, R.L. 1956. Aquatic Insects of California. Univ. Calif. Press, Berkeley.

Veno, P.A. 1976. Successional Relationships of Five Florida Plant Communities. Ecology 57:498-508.

Ware, F.J. 1969. Effects of Phosphatic Clay Pollution on the Peace River, Florida. S.E. Assoc. Game and Fish Comm. Annual Conf. pp. 359-373.

Weather Bureau. 1966. Climate. Florida Land and Water Resources, Southwest Florida. Fla. Brd. of Cons., Div. of Water Res. pp. 14-19.

White, W.A. 1970. The Geomorphology of the Florida Peninsula. Fla. Dept. Nat. Res. Geol. Bull. 51.

Wiggins, G.B. 1977. Larvae of the North American Caddisfly Genera (Tricoptera). Univ. Toronto Press, Toronto, Canada.

Wilhm, J.L. 1970. Range of Diversity Index in Benthic Macroinvertebrate Populations. J. Water Poll. Con. Fed. 42:R221-R224.

Williams, L. E. 1978. Florida Sandhill Crane. In Rare and Endangered Biota of Florida. v. 2. Birds. P.C.H. Pritchard and H.W. Kale, II [Eds.]. University Presses of Florida, Gainesville.

Woodwell, G.M. and R.H. Whittaker. 1968. Primary Production in Terrestrial Ecosystems. Amer. Zool. 8:19-30.

TABLE 8-1

LAND USE AND COVER CLASSIFICATION LEGEND FOR FIGURE 8-B

Level of Classification				
I	II	III	IV	Description
100				URBAN OR BUILT-UP
	110			Residential
		111		Single Unit, Low Density
	114			Transportation
		144		Major Roads and Highways
	190			Open Land and Other
		194		Abandoned Mine Piles
200				AGRICULTURE
	210			Cropland and Pastureland
		211		Row Crops
		212		Field Crops
		213		Improved Pasture
	230			Citrus
		231		Orange
400				FORESTED UPLANDS
	410			Coniferous Forest
		411		Pine Flatwoods
			4111	Cutover Flatwoods, Palmetto Range
		412		Longleaf Pine
			4121	Cutover Longleaf Pine - Sandhill Oaks
			4122	Longleaf Pine Flatwoods
	420			Hardwood Forest
		422		Other Hardwoods
			4221	Live Oak - Generally with a Mixed Understory
			4222	Live Oak - Generally with a Bahia Understory
			4223	Upland Mesic
			4224	Transition Mesic (Bottomland Hardwood)
			4225	Early Successional Hardwoods
	430			Mixed Forest
		431		Mixed Forest (Mixed Conifers and Hardwoods)
	440			Planted Forest
		441		Coniferous
			4411	Planted Pine - No Ground Vegetation
			4412	Planted Pine - Bahia Ground Cover
			4413	Planted Pine - Flatwoods Understory
	450			Clearcut
		451		Clearcut Bayhead
500				WATER
	510			Streams and Canals
		511		Streams
		512		Streams with Grass Beds
		513		Canals
		515		Canals with Dense Emergent Vegetation
		516		Canals with Woody Vegetation
	530			Reservoirs
		531		Unvegetated Reservoirs
	560			Other Water Areas
		563		Cattle Water Ponds
600				WETLANDS
	610			Wetland - Coniferous Forest
		611		Cypress
			6111	Pond Cypress, Isolated
	620			Wetland - Hardwood Forest
		621		Freshwater Swamp
			6211	Gum - Maple Swamp
			6212	Bayhead
			6213	Bay Strand
			6214	Myrtle Thicket
			6215	Mixed Hardwood Swamp
		622		Disturbed Freshwater Swamp
			6221	Disturbed Gum - Maple Swamp
			6222	Disturbed Bayhead
	640			Wetland - Vegetated, Non-Forested
		641		Freshwater Marsh
			6411	Isolated Upland Depressions
			6412	Wetland Depressions

Source: Land Use and Cover Categories through Level III are based on The Florida Land Use and Cover Classification System: A Technical Report. 1976. State of Florida, Department of Administration, Division of State Planning, Bureau of Comprehensive Planning. Tallahassee, Florida. Level IV categories adopted for the present study.

TABLE 8-2

ACREAGES OF LAND USE AND COVER CLASSIFICATIONS ON THE SOUTH FORT MEADE MINE SITE

Classification	Acreage	% of Total	Classification	Acreage	% of Total
DEVELOPED	(217.9)	(1.34)	WATER	(12.5)	(0.08)
111	4.4	.03	531	3.1	0.02
194	213.5	1.31	560	3.2	0.02
LAND	(14,003.6)	(85.97)	563	6.0	0.04
211	810.1	4.97	LAND-WATER INTERFACE	(2053.7)	(12.6)
212	29.6	0.18			
213	6,876.5	42.22	6111	78.0	0.48
231	566.2	3.48	6211	185.4	1.14
4111	3,389.2	20.81	6212	417.8	2.57
4121	23.5	0.14	6213	22.8	0.14
4221	109.3	0.67	6214	20.7	0.13
4222	117.9	0.72	6215	197.5	1.21
4223	659.8	4.05	6221	7.9	0.05
4224	916.7	5.63	6222	83.7	0.51
431	125.9	0.77	6411	883.4	5.42
4411	17.3	0.11	6412	156.5	0.96
4412	204.4	1.25			
4413	118.4	0.73		TOTAL ACREAGE: 16,288	
451	38.8	0.24			

SOURCE: STUDY DATA

TABLE 8-3

VEGETATION SPECIES OBSERVED OR EXPECTED TO OCCUR ON THE SOUTH FORT MEADE MINE SITE

Species	Species Distribution by Community Types[1]																						
	111	144	211	212	213	231	411	412	422	431	441	451	511	512	513	515	516	531	563	611	621	622	641
TREES																							
Acer negundo Boxelder									x														
Acer rubrum Red maple	x	x					x		x	x	x									x	x	x	x
Albizia julibrissen Mimosa	x																						
Aralia spinosa Devil's walking stick									x														
Carpinus caroliniana Blue beech									x												x		
Carya aquatica Bitter pecan									x												x		
Carya glabra Pignut hickory									x	x													
Casuarina equisetifolia Australian pine	x																						
Celtis laevigata Sugarberry	x								x											x	x		
Cercis canadensis Eastern redbud	x								x	x													
Chionanthus virginicus Fringetree									x	x													
Cinnamomum camphora Camphor tree	x								x														
Citrus spp. (Citrus fruits)	x					x			x	x													
Cornus florida Flowering dogwood	x								x	x											x		
Cornus foemina Florida dogwood									x												x		
Crataegus flava Hawthorne	x	x					x	x	x	x	x												
Crataegus marshallii Parsley haw		x							x												x		
Diospyros virginiana Persimmon	x	x	x	x	x		x	x	x	x	x												
Fraxinus caroliniana Pop ash																					x	x	
Fraxinus profunda Pumpkin ash																					x	x	
Gleditsia aquatica Water locust									x												x		
Gordonia lasianthus Loblolly bay																				x	x	x	
Ilex ambigua Carolina holly									x														
Ilex cassine Dahoon holly									x												x		
Ilex coriaceae Large gallberry									x											x			
Ilex glabra Gallberry							x	x	x	x	x										x		
Ilex opaca American holly	x								x														
Ilex vomitoria Yaupon									x														
Liquidambar styraciflua Sweetgum	x	x			x		x	x	x		x										x	x	
Magnolia grandiflora Southern magnolia	x							x	x														
Magnolia virginica Sweetbay							x		x											x	x	x	
Morus rubra Red mulberry									x														
Myrica cerifera Southern waxmyrtle	x						x	x	x	x										x	x		
Nyssa sylvatica Blackgum									x											x	x	x	
Ostrya virginiana Eastern hophornbeam									x														
Persea palustris Swamp bay									x												x		
Pinus elliottii Slash pine											x												
Pinus palustris Longleaf pine	x						x	x	x	x													
Prunus angustifolia Chickasaw plum								x															
Prunus caroliniana Carolina laurelcherry									x														
Prunus serotina Black cherry							x	x	x														
Prunus umbellata Flatwoods plum					x		x		x														
Quercus geminata Scrub live oak	x						x	x		x	x												
Quercus hemisphaerica Laurel oak	x						x		x	x	x									x	x		

TABLE 8-3 (Continued)

Species	Species Distribution by Community Types[1]																						
	111	144	211	212	213	231	411	412	422	431	441	451	511	512	513	515	516	531	563	611	621	622	641
Quercus incana Bluejack oak							X	X															
Quercus laevis Turkey oak							X	X															
Quercus nigra Water oak	X				X		X	X	X	X	X									X	X		
Quercus virginiana Live oak	X				X		X	X	X	X	X												
Rhus copallina Shining sumac	X				X		X	X	X	X	X										X		
Sabal palmetto Cabbage palm	X				X			X	X	X											X		
Salix caroliniana Coastal plain willow									X				X	X	X	X	X				X		X
Taxodium distichum var. *nutans*[2] Pond cypress																				X			
Taxodium distichum var. *distichum*[2] Bald cypress													X	X			X				X		
Ulmus alata Winged elm									X												X		
Ulmus americana var. *floridana* Florida elm									X												X		
Zanthoxylum clava-herculis Toothache tree	X				X			X	X														
SHRUBS																							
Aesculus pavia Red buckeye									X														
Aronia arbutifolia Red chokecherry							X		X	X													
Asimina parviflora Dwarf pawpaw					X		X		X	X	X												
Asimina reticulata Pawpaw					X		X			X													
Asimina speciosa Pawpaw					X		X	X		X	X												
Baccharis glomeruliflora Groundsel tree	X	X			X						X										X		
Befaria racemosa Tarflower							X																
Callicarpa americana American beautybush	X	X			X			X	X	X	X										X		
Ceanothus americanus Jersey tea							X	X	X	X	X												
Cephalanthus occidentalis Buttonbush									X									X		X	X		X
Euonymus americanus Strawberry bush									X														
Hypericum spp. St. John's wort		X			X		X	X	X	X	X				X	X	X			X	X	X	X
Itea virginica Virginia willow									X											X	X		
Lantana camara Lantana	X	X			X				X	X	X	X											
Ludwigia peruviana Primrose willow																				X	X		X
Ludwigia pilosa Hairy primrose																				X			X
Lyonia fruticosa Staggerbush							X														X		
Lyonia lucida Fetterbush							X				X										X		
Quercus minima Ground oak							X	X		X	X												
Quercus pumila Runner oak							X	X		X	X												
Rhapidophyllum hystrix Needle palm																					X		
Rhododendron serrulatum Swamp honeysuckle									X												X		
Rubus spp. Blackberry					X		X		X	X	X	X									X	X	
Sabal minor Dwarf cabbage palm									X												X		
Sambucus simpsonii Elderberry	X	X			X															X	X	X	
Serenoa repens Saw palmetto					X		X	X	X	X	X										X		
Styrax americana Storax									X	X													
Urena lobata Caesarweed	X	X			X	X			X	X													
Vaccinium arboreum Tree sparkleberry									X	X											X		
Vaccinium myrsinites Dwarf huckleberry		X					X	X		X	X												
Vaccinium stamineum Squaw huckleberry								X															

TABLE 8-3 (Continued)

Species	Species Distribution by Community Types[1]																						
	111	144	211	212	213	231	411	412	422	431	441	451	511	512	513	515	516	531	563	611	621	622	641
Viburnum nudum Possum haw							x																
Viburnum obovatum Walter's viburnum									x														
VINES																							
Ampelopsis arborea Pepper vine									x												x	x	
Anisostichus capreolata Cross vine									x												x	x	
Berchemia scandens Rattan vine									x												x	x	
Campsis radicans Trumpet vine									x												x	x	
Cassytha filiformis Woe vine													x	x	x	x	x				x	x	x
Dioscorea villosa Wild yam									x														
Gelsemium sempervirens Yellow jessamine					x		x		x														
Jasminum multiflorum Jasmine									x														
Lonicera japonica Japanese honeysuckle									x														
Lonicera sempervirens Coral honeysuckle									x														
Mikania scandens Climbing hemp vine									x												x	x	
Parthenocissus quinquefolia Virginia creeper									x	x											x	x	
Passiflora incarnata May pop					x		x		x	x													
Rhus radicans Poison ivy							x		x	x											x	x	
Smilax auriculata Auricled greenbrier		x			x		x	x	x	x	x									x	x		
Smilax bona-nox Catbrier		x			x		x	x	x	x	x									x	x		
Smilax glauca Greenbrier							x		x												x		
Smilax laurifolia Bamboo brier							x																
Smilax smallii Small's greenbrier									x												x		
Smilax walteri Greenbrier									x												x		
Vitis aestivalis Summer grape		x					x	x	x	x	x												
Vitis rotundifolia Muscadine		x					x	x	x	x	x									x	x		
Vitis vulpina Fox grape		x					x	x	x	x	x												
FERNS & FERN ALLIES																							
Azolla caroliniana Azolla													x	x	x	x	x			x	x		x
Blechnum serrulatum Blechnum fern									x											x	x		
Fontinalis sp. Water moss													x	x	x	x	x						
Lorinseria areolata Chain fern									x												x		
Lycopodium spp. Club moss		x					x				x												
Lygodium japonicum Climbing fern	x	x							x												x	x	
Osmunda cinnamomea Cinnamon fern							x		x				x	x	x	x	x				x		x
Osmunda regalis Royal fern									x				x	x	x	x	x				x		x
Phlebodium aureum Golden polypody									x	x											x		
Polypodium polypodioides Resurrection fern									x														
Pteridium aquilinum Bracken fern		x					x	x	x	x	x												
Sphagnum sp. Sphagnum moss									x											x	x		
Thelypteris torresiana Thelypteris fern									x											x	x		
Woodwardia areolata Netted chain fern									x												x		
Woodwardia virginica Virginia chain fern									x											x	x		x
HERBS																							
Abrus precatorius Crab's eye									x														

TABLE 8-3 (Continued)

Species	Species Distribution by Community Types¹																						
	111	144	211	212	213	231	411	412	422	431	441	451	511	512	513	515	516	531	563	611	621	622	641
Aletris aurea Yellow colicroot							x				x		x	x	x	x	x						x
Alternanthera philoxeroides Alligator weed													x	x	x	x				x	x		x
Alysicarpus vaginalis Clover	x	x			x																		
Amaranthus hybridus Pigweed		x	x	x	x	x																	
Amaranthus retroflexus Pigweed																					x		
Ambrosia artemisifolia Common ragweed		x	x	x	x	x			x														
Ambrosia trifida Giant ragweed		x	x	x	x	x																	
Andropogon glomeratus Bluestem							x				x		x	x	x	x	x						x
Andropogon virginicus Broomsedge		x			x		x	x	x	x	x												
Ardisia sp. Ardisia									x														
Arisaema triphyllum Jack-in-the-pulpit									x												x		
Aristida spiciformis Three-awn					x		x	x		x													
Aristida stricta Wiregrass							x	x		x													
Asclepias currassavica Milkweed									x												x		
Asclepias humistrata Milkweed				x	x	x		x															
Asclepias lanceolata Milkweed							x																
Asclepias perennis Milkweed				x	x	x	x	x		x													
Asclepias tuberosa Milkweed				x	x	x	x	x		x													
Aster dumosus Aster		x					x																
Aster reticulatus Aster		x					x																
Aster tortifolius Aster		x					x																
Axonopus compressus Carpet grass	x	x		x	x	x																	
Axonopus furcatus Carpet grass	x	x					x													x			
Bacopa caroliniana Water mint																				x			x
Bacopa monnieri Water hyssop													x	x	x	x	x		x	x			x
Balduina angustifolia Annual balduina							x	x															
Berlandiera subacaulis Green eyes								x		x													
Bidens bipinnata Beggar lice			x	x	x	x			x														
Bidens mitis Beggar lice									x												x		
Bidens pilosa Beggar lice		x			x	x					x												
Boehmeria cylindrica False nettle									x			x									x	x	
Bonamia sp. Bonamia								x															
Cacalia lanceolata Indian plantain								x		x													
Calystegia sepium Hedge bindweed					x	x																	
Canna x *generalis* Golden canna	x												x	x		x	x				x		
Carex spp. Caric sedges		x			x	x			x				x	x	x	x	x	x	x	x	x	x	x
Carphephorus corymbosus Carphephorus							x	x		x													
Carphephorus odoratissimus Deer tongue							x	x		x	x												
Cassia aspera Hairy cassia			x	x	x	x					x												
Cassia fasciculata Partridge pea			x	x	x	x	x	x	x	x	x												
Cassia obtusifolia Sicklepod		x	x	x		x																	
Centella asiatica Coinwort	x	x					x	x												x	x		x
Chaptalia tomentosa Sunbonnet							x																
Chloris petraea Stiff-leaved chloris								x	x														
Chrysobalanus oblongifolius Gopher apple					x		x	x		x	x												

TABLE 8-3 (Continued)

Species	Species Distribution by Community Types[1]																						
	111	144	211	212	213	231	411	412	422	431	441	451	511	512	513	515	516	531	563	611	621	622	641
Chrysopsis subulata Golden aster								x															
Cicuta maculata Water hemlock								x													x	x	
Cirsium horridulum Horrid thistle		x			x																		
Cladium jamaicense Sawgrass														x	x	x					x		
Clematis reticulata Virgin's bower									x												x	x	
Cnidoscolus stimulosus Stinging nettle	x	x			x	x	x	x		x	x												
Colocasia esculentum Elephant ears	x												x			x					x		
Commelina diffusa Dayflower	x	x							x											x	x		
Crinum americanum Swamp lily									x				x	x						x	x		
Crotalaria rotundifolia Rattlebox					x		x	x		x	x												
Croton glandulosus Croton							x	x															
Cynanchum sp. Milkweed vine									x	x													
Cyperus spp. Nutsedges	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x			x	x	x	x
Desmodium canum Tick clover	x	x			x		x	x	x	x	x												
Desmodium paniculatum Beggar ticks		x			x		x	x															
Desmodium rotundifolium Beggar ticks		x			x	x	x																
Dichondra repens Dichondra							x		x											x	x	x	x
Dichromena colorata Whitetop sedge	x	x			x		x		x	x										x	x		x
Diodia virginiana Buttonweed	x	x			x	x														x	x		
Dischoriste oblongifolia Twinflower					x	x	x	x															
Drosera spp. Sundew																							x
Drymaria cordata Drymaria					x	x			x														
Egeria densa Egeria													x	x	x	x	x						
Eichhornia crassipes Water hyacinth													x	x	x	x	x						x
Eleocharis spp. Spikerushes					x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Elephantopus tomentosus Elephant's foot							x	x	x	x	x												
Epidendrum conopseum Greenfly orchid									x											x	x	x	
Eragrostis elliottii Love grass							x	x	x	x	x												
Eragrostis refracta Love grass							x																
Erigeron canadensis Horseweed		x			x																		
Erigeron strigosus Daisy fleabane		x			x																		
Erigeron vernus Daisy fleabane		x					x				x												
Eriocaulon decangulare Pipewort					x		x				x												x
Eryngium baldwinii Eryngium							x				x												
Eryngium yuccifolium Button snakeroot							x				x												
Erythrina herbacea Cherokee bean	x	x							x														
Eupatorium capillifolium Dog fennel	x	x			x	x	x		x	x	x									x			
Eupatorium compositifolium Dog fennel	x	x			x					x													
Eupatorium recurvans Eupatorium					x					x													x
Froelichia floridana Cottonweed		x			x		x	x	x	x													x
Fuirena spp. Umbrella grass	x	x			x								x	x	x	x	x						x
Galactia elliottii Milk pea		x									x												
Galium obtusum Bedstraw																							x
Gnaphalium pennsylvanicum Rabbit tobacco		x			x		x	x		x	x												

TABLE 8-3 (Continued)

Species	Species Distribution by Community Types[1]																						
	111	144	211	212	213	231	411	412	422	431	441	451	511	512	513	515	516	531	563	611	621	622	641
Habenaria clavellata Green woodland orchid									X												X		
Hedyotis procumbens Innocence								X															
Hedyotis uniflora Hedyotis					X	X	X	X															
Helenium amarum Bitter sneezeweed	X	X			X	X	X		X														
Helianthemum corymbosum Frostweed											X												
Helianthus angustifolius Sunflower							X																
Helianthus radula Sunflower							X																
Heterotheca graminifolia Grass-leaved golden aster	X	X					X	X	X														
Heterotheca hyssopifolia Golden aster							X																
Hieracium megacephalon Hawkweed								X															
Hydrilla verticillata Hydrilla													X	X	X	X	X						
Hydrochloa carolinensis Water grass																				X			
Hydrocotyle umbellata Pennywort	X	X			X		X	X	X	X			X	X	X	X	X			X	X	X	X
Hypericum fasciculatum St. John's wort																							X
Hypericum myrtifolium St. John's wort																							X
Hypericum stans St. John's wort																							X
Hypericum tetrapetalum St. John's wort							X														X		
Hypoxis hirsuta Yellow star grass					X		X		X				X	X	X	X	X				X	X	X
Impatiens wallerana Jewelweed																					X		
Ipomea quamoclit Morning glory		X				X			X	X													
Iris savannarum Iris									X											X	X		X
Juncus effusus Rush													X	X	X	X	X			X	X		X
Juncus repens Rush													X	X	X	X	X			X	X		X
Lachnanthes tinctoria Redroot							X																
Lachnocaulon anceps Bog button							X																
Lactuca floridana Wild lettuce					X				X	X											X		
Lamium amplexicaule Henbit	X	X			X				X														
Lemna spp. Duckweed													X	X	X	X	X				X		X
Liatris graminifolia Blazing star						X	X			X													
Lilium catesbaei Pine lily							X																
Linaria floridana Toad flax		X			X	X		X	X	X	X												
Lippia nodiflora Match heads	X	X			X		X		X	X	X		X	X	X	X	X			X	X	X	X
Ludwigia arcuata Primrose																							X
Ludwigia repens Primrose					X								X	X	X	X	X			X	X		X
Ludwigia suffruticosa Primrose							X																
Ludwigia spp. Primrose																							X
Lycopus rubellus Lycopus																				X			
Micranthemum umbrosum Shade mudflower							X						X	X	X	X	X				X		X
Mitchella repens Partridge berry									X														
Momordica charantia Balsam apple		X							X														
Murdannia nudiflora Murdannia																				X			
Myriophyllum brasiliense Parrot feather													X	X	X	X	X						

TABLE 8-3 (Continued)

Species	Species Distribution by Community Types[1]																						
	111	144	211	212	213	231	411	412	422	431	441	451	511	512	513	515	516	531	563	611	621	622	641
Najas sp. Pondweed													X	X	X	X	X						
Nuphar luteum Spatterdock													X	X	X	X	X						X
Nymphoides aquatica Floating hearts																							X
Oenothera spp. Primrose		X			X		X		X	X													
Opuntia compressa Prickly pear	X	X			X		X	X	X														
Opuntia drummondi Prickly pear	X	X						X	X														
Orontium aquaticum Golden club													X	X	X	X	X			X	X		X
Oxalis dilenii Yellow wood sorrel	X	X			X	X			X	X													
Parietaria floridana Pellitory									X											X	X		
Panicum anceps Panic grass							X		X														
Panicum commutatum Panic grass								X	X												X		
Panicum hemitomon Maidencane							X	X	X	X	X									X			X
Panicum rigidulum Panic grass							X	X	X														
Paspalum conjugatum Paspalum			X	X	X	X			X											X			
Paspalum notatum Bahia	X	X	X	X	X	X			X														
Paspalum plicatum Paspalum																				X			
Paspalum setaceum Paspalum	X	X	X	X	X	X		X															
Phoebanthus grandiflora Phoebanthus							X	X		X													
Peltandra virginica Arrowhead													X	X	X	X	X			X	X		X
Pluchea imbricata Marsh fleabane							X													X			X
Pluchea rosea Marsh fleabane					X																		X
Poa commutatum Poa grass									X														
Pogonia ophioglossoides Rose pogonia		X					X																X
Polygala cymosa Polygala		X					X																X
Polygala lutea Polygala		X					X				X												
Polygala nana Polygala		X					X				X												
Polygonum hydropiperoides Smartweed													X	X	X	X	X			X	X	X	X
Polypremum procumbens Polypremum		X			X	X			X														
Pontederia cordata Pickerelweed													X	X	X	X	X			X	X		X
Proserpinaca palustris Mermaid weed													X	X	X	X	X						X
Pterocaulon pycnostachyum Rabbit tobacco		X			X	X	X	X		X	X												
Ptilimnium capillaceum Mock bishop weed							X		X														
Rhexia mariana Meadowbeauty							X													X			X
Rhus radicans Poison ivy							X	X	X	X	X	X									X	X	
Rhynchosia reniformis Dollarweed		X					X	X															
Rhynchosia sp. Dollarweed		X					X																
Rhynchospora fascicularis Beakrush									X														
Rhynchospora filifolia Beakrush							X																

TABLE 8-3 (Continued)

Species	Species Distribution by Community Types[1] 111	144	211	212	213	231	411	412	422	431	441	451	511	512	513	515	516	531	563	611	621	622	641
Rhynchospora plumosa Beakrush							X																
Rhynchospora shoenoides Beakrush																							X
Richardia scabra Richardia			X	X	X	X			X														
Rubus penetrans Blackberry					X		X	X	X	X	X										X	X	
Rubus trivialis Dewberry		X			X		X		X	X	X												
Sabatia grandiflora Marsh pink		X			X		X			X													X
Sacciolepis striata American cupscale grass																				X			
Sagittaria graminea Arrowroot																				X	X		X
Sagittaria lanceolata Arrowroot																				X	X		
Sagittaria latifolia Arrowroot													X	X	X	X	X						X
Salvia coccinea Sage		X			X		X	X	X	X	X	X											
Salvia lyrata Lyre-leaf sage					X			X															
Saururus cernuus Lizard's tail																				X	X		X
Setaria geniculata Foxtail grass					X		X	X	X	X	X												
Solanum americanum Nightshade									X														
Solidago spp. Goldenrod		X			X		X	X	X	X	X	X											
Sonchus asper Sow thistle		X			X																		
Sophronanthe hispida Hedge hyssop							X																
Sorgastrum secundum Lopsided Indiangrass							X	X		X													
Sparganium americanum Bur reed													X	X	X	X	X			X	X		X
Spartina bakeri Sand cordgrass					X								X	X	X	X	X			X	X		X
Specularia perfoliata Venus' looking-glass		X			X				X														
Sporobolus poirettii Smutgrass		X			X																		
Stillingia sylvatica Queen's delight							X	X															
Tephrosia hispidula Tephrosia		X					X	X		X													
Tephrosia spicata Tephrosia		X					X			X	X												
Thalia geniculata Arrowroot																					X		X
Tillandsia bartrami Bartram's air plant	X					X	X		X	X										X	X		
Tillandsia usneoides Spanish moss	X					X	X		X	X										X	X		
Triadenum virginicum St. John's wort																				X			X
Utricularia spp. Bladderwort																				X	X		X
Valisneria neotropicalis Eel grass													X	X	X	X	X						
Viola floridana Florida violet		X			X		X		X	X	X												
Viola lanceolata Lance-leaved violet							X		X	X	X												
Xyris elliottii Yellow-eyed grass					X		X						X	X	X	X	X						X
Zephyranthes treatiae Zephyr lily		X					X	X	X	X													
Zizaniopsis miliacea Water millet													X	X	X	X	X			X			

SOURCE: STUDY DATA

[1] Level III categories from the Florida Land Use and Cover Classification System: A Technical Report (1977).

[2] Source: Little, E.L., Jr. 1979. Checklist of United States Trees.

TABLE 8-4

OCCURRENCE AND RELATIVE ABUNDANCE OF MAMMALS ON THE SOUTH FORT MEADE MINE SITE

Species[1]	Abundance[2]	Season of Occurrence[3]	Habitat Association[4]											
			100	210	230	410	420	430	440	450	500	610	620	640
Opossum Didelphis virginiana	A	R	X	X	X	X	X	X	X	X	X	X	X	X
Southeastern Shrew Sorex longirostris	U	R		X		X	X	X	X	X				
Short-tailed Shrew Blarina brevicauda	C	R	X	X		X		X					X	
Least Shrew Cryptotis parva	C	R	X	X		X								
*Eastern Mole Scalopus aquaticus	A	R	X	X	X	X	X	X	X	X				
Eastern Pipistrelle Pipistrellus subflavus	R	R					X				X	X	X	
Big Brown Bat Eptesicus fuscus	R	R	X	X		X	X	X	X	X		X	X	X
Red Bat Lasiurus borealis	U	R	X	X		X	X	X	X	X	X	X	X	X
Seminole Bat Lasiurus seminolus	U	R	X	X		X	X	X	X	X	X	X	X	X
Hoary Bat Lasiurus cinereus	R	F,W,S				X	X	X	X	X	X	X	X	X
Northern Yellow Bat Lasiurus intermedius	C	R	X	X	X	X	X	X	X	X	X	X	X	X
Evening Bat Nycticeius humeralis	U	R	X	X	X	X	X	X	X	X	X	X	X	X
Eastern Big-eared Bat Plecotus rafinesquii	R	R	X	X			X					X	X	
Mexican Free-tailed Bat Tadarida brasiliensis	U	R	X	X	X	X	X	X	X	X	X	X	X	X
*Nine-banded Armadillo Dasypus novemcinctus	A	R	X	X	X	X	X	X	X	X		X	X	
Marsh Rabbit Sylvilagus palustris	C	R		X		X	X	X				X	X	X
*Eastern Cottontail Rabbit Sylvilagus floridanus	A	R	X	X	X	X	X	X	X	X				
*Eastern Gray Squirrel Sciurus carolinensis	A	R	X			X	X	X	X	X		X	X	
*Sherman's Fox Squirrel Sciurus niger shermani	U	R	X		X	X	X	X	X	X				
*Southern Flying Squirrel Glaucomys volans	C	R	X			X	X	X	X	X		X	X	
*Southeastern Pocket Gopher Geomys pinetis	C	R	X	X	X	X	X	X	X	X				
Rice Rat Oryzomys palustris	C	R		X							X		X	X
Eastern Harvest Mouse Reithrodontomys humulis	U	R		X		X								X
Oldfield Mouse Peromyscus polionotus	C	R		X	X					X				
Cotton Mouse Peromyscus gossypinus	A	R	X	X	X	X	X	X	X	X		X	X	X

TABLE 8-4 (Continued)

Species[1]	Abundance[2]	Season of Occurrence[3]	Habitat Association[4] 100	210	230	410	420	430	440	450	500	610	620	640
Florida Mouse *Peromyscus floridanus*	N	R												
Golden Mouse *Ochrotomys nuttalli*	U	R										X	X	
Hispid Cotton Rat *Sigmodon hispidus*	A	R	X	X	X	X	X	X	X	X		X	X	X
Eastern Woodrat *Neotoma floridana*	U	R					X	X					X	
Round-tailed Muskrat *Neofiber alleni*	U	R		X										X
Black Rat *Rattus rattus*	C	R	X	X		X	X	X	X	X				
Norway Rat *Rattus norvegicus*	U	R	X	X										
House Mouse *Mus musculus*	C	R		X	X	X				X				X
Red Fox *Vulpes vulpes*	U	R	X	X	X					X			X	X
Gray Fox *Urocyon cinereoargenteus*	U	R	X			X	X	X		X				
Florida Black Bear *Ursus americanus floridanus*	N	R												
*Raccoon *Procyon lotor*	A	R	X	X	X	X	X	X	X	X	X	X	X	X
Florida Long-tailed Weasel *Mustela frenata peninsulae*	R	R		X	X	X	X	X	X				X	X
Eastern Spotted Skunk *Spilogale putorius*	U	R		X		X	X	X	X	X				
*Striped Skunk *Mephitis mephitis*	C	R	X	X	X	X	X	X	X	X				X
*River Otter *Lutra canadensis*	C	R									X	X	X	X
Florida Panther *Felis concolor coryi*	N	R												
Bobcat *Felis rufus*	C	R	X	X	X	X	X	X	X	X	X	X	X	X
White-tailed Deer *Odocoileus virginianus*	U	R		X	X	X	X	X	X	X	X	X	X	X
*Wild Hog *Sus scrofa*	C	R		X	X	X	X	X	X	X	X	X	X	X
*Dog *Canis familiaris*	C	R	X	X	X									
*Cat *Felis catus*	C	R	X	X	X									
*Cattle *Bos tarus*	A	R	X	X	X	X	X	X	X	X	X	X	X	X

Source: Study Data

[1] * = animal observed on site

[2] A = Abundant = frequently observed
C = Common = often observed
U = Uncommon = infrequently observed
R = Rare = very infrequently observed
N = Not Expected

[3] F = Fall
W = Winter
S = Spring
Sm = Summer
R = Resident

[4] Level III categories from the *Florida Land Use and Cover Classification System: A Technical Report* (1977).

TABLE 8-5

OCCURRENCE AND RELATIVE ABUNDANCE OF BIRDS ON THE SOUTH FORT MEADE MINE SITE

Species[1]	Abundance[2]	Season of Occurrence[3]	Habitat Association[4]											
			100	210	230	410	420	430	440	450	500	610	620	640
Common Loon *Gavia immer*	N	F,W,S									X			
Horned Grebe *Podiceps auritus*	R	F,W,S									X			
*Pied-billed Grebe *Podilymbus podiceps*	C	R									X			X
Anhinga *Anhinga anhinga*	C	R									X			
Double-crested Cormorant *Phalacrocorax auritus*	C	R									X			
*Great Blue Heron *Ardea herodias*	C	R									X	X	X	X
*Green Heron *Butorides striatus*	A	R									X	X	X	X
*Little Blue Heron *Florida caerulea*	A	R									X	X	X	X
*Cattle Egret *Bubulcus ibis*	A	R	X	X	X						X		X	
*Great Egret *Casmerodius albus*	A	R									X	X	X	X
*Snowy Egret *Egretta thula*	C	R									X			
*Louisiana Heron *Hydranassa tricolor*	C	R									X			
Black-crowned Night Heron *Nycticorax nycticorax*	U	R									X		X	
Yellow-crowned Night Heron *Nyctanassa violacea*	R	R									X		X	
Least Bittern *Ixobrychus exilis*	C	R											X	X
American Bittern *Botaurus lentiginosus*	C	F,W,S											X	X
*Wood Stork *Mycteria americana*	U	R									X	X	X	X
*Glossy Ibis *Plegadis falcinellus*	U	R		X										X
*White Ibis *Eudocimus albus*	C	R		X										X
Mallard *Anas platyrhynchos*	R	F,W,S									X	X		X
Black Duck *Anas platyrhynchos rubripes*	U	F,W,S									X	X		X
Mottled Duck *Anas platyrhynchos fulvigula*	U	R									X	X		X
Gadwall *Anas strepera*	U	F,W,S									X	X		X
Pintail *Anas acuta*	U	F,W,S									X	X		X
Green-winged Teal *Anas crecca*	C	F,W,S									X	X		X
Blue-winged Teal *Anas discors*	C	F,W,S									X	X		X
American Wigeon *Anas americana*	R	F,W,S									X	X		X
Northern Shoveler *Anas clypeata*	U	F,W,S									X	X		X
Wood Duck *Aix sponsa*	C	R									X	X	X	X
Redhead *Aythya americana*	N	F,W,S									X			X
Ring-necked Duck *Aythya collaris*	R	F,W,S									X			X
Canvasback *Aythya valisineria*	N	F,W,S									X			
Lesser Scaup *Aythya affinis*	N	F,W,S									X			
Common Goldeneye *Bucephala clangula*	N	F,W,S									X			
Bufflehead *Bucephala albeola*	N	F,W,S									X			
Ruddy Duck *Oxyura jamaicensis*	R	F,W,S									X			X

TABLE 8-5 (Continued)

Species[1]	Abundance[2]	Season of Occurrence[3]	Habitat Association[4]											
			100	210	230	410	420	430	440	450	500	610	620	640
Hooded Merganser *Lophodytes cucullatus*	U	F,W,S									X			X
*Turkey Vulture *Cathartes aura*	A	R	X	X	X	X	X	X	X	X		X	X	X
*Black Vulture *Coragyps atratus*	A	R	X	X	X	X	X	X	X	X		X	X	X
Swallow-tailed Kite *Elanoides forficatus*	R	S,Sm,F					X	X			X	X	X	
Sharp-shinned Hawk *Accipiter striatus*	C	F,W,S			X	X	X	X	X	X			X	
Cooper's Hawk *Accipiter cooperii*	R	R			X	X	X	X	X	X			X	
*Red-tailed Hawk *Buteo jamaicensis*	C	R	X	X	X	X	X	X	X	X				
*Red-shouldered Hawk *Buteo lineatus*	A	R					X	X				X	X	X
Broad-winged Hawk *Buteo platypterus*	U	F,W,S					X						X	
Short-tailed Hawk *Buteo brachyurus*	N	R				X							X	
Southern Bald Eagle *Haliaeetus l. leucocephalus*	R	R		X	X	X	X	X	X	X	X	X	X	X
Marsh Hawk *Circus cyaneus*	A	F,W,S	X	X	X	X				X				X
Osprey *Pandion haliaetus carolinensis*	C	R									X			
Peregrine Falcon *Falco peregrinus*	R	F,S		X	X	X	X	X	X	X				
Merlin *Falco columbaris*	R	F,W,S		X	X	X	X	X	X	X				
*American Kestrel *Falco s. sparverius*	C	F,W,S	X	X	X	X	X	X	X	X				
Southeastern American Kestrel *Falco sparverius paulus*	R-N	R				X								
*Bobwhite *Colinus virginianus*	A	R	X	X	X	X	X	X	X	X				
Turkey *Meleagris gallopavo*	N	R				X	X	X	X					
Greater Sandhill Crane *Grus canadensis tabida*	U	F,W,S		X		X								X
*Florida Sandhill Crane *Grus canadensis pratensis*	U	R		X		X								X
Limpkin *Aramus guarauna*	U	R									X			
King Rail *Rallus elegans*	U	R												X
Virginia Rail *Rallus limicola*	U	F,W,S												X
Sora *Porzana carolina*	U	F,W,S												X
Yellow Rail *Coturnicops noveboracensis*	N	F,W,S		X										
Black Rail *Laterallus jamaicensis*	N	F,W,S		X										X
Purple Gallinule *Porphyrula martinica*	R	R									X			X
Common Gallinule *Gallinula chloropus*	U	R									X			X
American Coot *Fulica americana*	U	R									X			X
*Killdeer *Charadrius vociferus*	C	R	X	X	X					X				
American Woodcock *Philohela minor*	U	F,W,S					X	X						
*Common Snipe *Capella gallinago*	C	F,W,S	X	X	X					X				
Upland Sandpiper *Bartramia longicauda*	N	F		X	X									
Spotted Sandpiper *Actitis macularia*	U	F,W,S									X			
Solitary Sandpiper *Tringa solitaria*	R	F,W,S									X			

TABLE 8-5 (Continued)

Species[1]	Abundance[2]	Season of Occurrence[3]	Habitat Association[4]											
			100	210	230	410	420	430	440	450	500	610	620	640
*Greater Yellowlegs *Tringa melanoleucus*	C	F,W,S									X			X
Lesser Yellowlegs *Tringa flavipes*	U	F,W,S									X			X
Pectoral Sandpiper *Calidris melanotos*	R	F,S		X	X									
Least Sandpiper *Calidris minutilla*	R	F,S		X	X									
Long-billed Dowitcher *Limnodromus scolopaceus*	R	F,S		X	X									
Black-necked Stilt *Himantopus mexicanus*	U	S,Sm,F									X			X
Herring Gull *Larus argentatus*	R	W		X	X									
Ring-billed Gull *Larus delawarensis*	U	F,W,S		X	X									
Laughing Gull *Larus atricilla*	U	F,S		X	X									
Forster's Tern *Sterna forsteri*	U	F,W,S									X			
Least Tern *Sterna albifrons*	R	S,Sm,F									X			
Royal Tern *Sterna maxima*	M	Sm									X			
Caspian Tern *Sterna caspia*	M	Sm		X	X						X			
Black Tern *Chlidonias niger*	R	Sm,F		X	X						X			
Rock Dove, Pigeon *Columba livia*	U	R	X	X	X									
*Mourning Dove *Zenaida macroura*	A	R	X	X	X	X	X	X	X	X				
*Ground Dove *Columbina passerina*	C	R	X	X	X	X	X		X					
*Yellow-billed Cuckoo *Coccyzus americanus*	A	S,Sm,F					X						X	
Black-billed Cuckoo *Coccyzus erythropthalmus*	R	F,S					X						X	
Barn Owl *Tyto alba*	R	R	X	X	X	X								X
Screech Owl *Otus asio*	U	R			X		X	X						
Great Horned Owl *Bubo virginianus*	C	R	X	X	X	X								
*Florida Burrowing Owl *Athene cunicularia floridana*	U	R		X		X								
*Barred Owl *Strix varia*	C	R					X						X	
*Chuck-will's-widow *Caprimulgus carolinensis*	C	S,Sm,F			X	X								
Whip-poor-will *Caprimulgus vociferus*	U	F,S			X	X								
*Common Nighthawk *Chordeiles minor*	A	S,Sm,F	X	X	X	X								
Chimney Swift *Chaetura pelagica*	C	S,Sm,F	X	X	X	X	X	X	X	X	X	X	X	X
*Belted Kingfisher *Megaceryle alcyon*	C	R									X			
*Common Flicker *Colaptes auratus*	U	R	X	X	X	X	X	X	X	X		X	X	
*Pileated Woodpecker *Dryocopus pileatus*	C	R	X		X		X							
*Red-bellied Woodpecker *Melanerpes carolinus*	A	R					X	X					X	
*Red-headed Woodpecker *Melanerpes erythrocephalus*	U	R	X		X	X	X	X	X			X	X	
Yellow-bellied Sapsucker *Sphyrapicus varius*	C	F,W,S	X			X	X	X						
Hairy Woodpecker *Picoides villosus audubonii*	R	R			X	X	X	X	X	X			X	
Downy Woodpecker *Picoides pubescens*	C	R				X								

TABLE 8-5 (Continued)

Species[1]	Abundance[2]	Season of Occurrence[3]	Habitat Association[4]											
			100	210	230	410	420	430	440	450	500	610	620	640
Red-cockaded Woodpecker Picoides borealis	N	R			X	X	X	X	X	X			X	
Ruby-throated Hummingbird Archilochus colubris	U	S,Sm,F			X		X						X	
*Eastern Kingbird Tyrannus tyrannus	C	S,Sm,F	X	X	X	X								
Western Kingbird Tyrannus verticalis	R	F,W,S	X	X	X	X								
Scissor-tailed Flycatcher Muscivora forficata	X	F,W,S	X	X	X	X								
*Great Crested Flycatcher Myiarchus crinitus	C	S,Sm,F	X		X	X	X	X	X	X			X	
*Eastern Phoebe Sayornis phoebe	C	F,W,S	X	X	X	X	X	X	X	X			X	
Acadian Flycatcher Empidonax virescens	U	F,S					X						X	
Eastern Wood Pewee Contopus virens	U	F,S				X								
*Tree Swallow Iridoprocne bicolor	A	F,W,S	X	X	X	X				X			X	
Bank Swallow Riparia riparia	N	F,S	X	X	X	X				X				
Rough-winged Swallow Stelgidopteryx ruficollis	R	F,S	X	X	X	X				X				
Barn Swallow Hirundo rustica	C	S,F	X	X	X	X				X				X
Cliff Swallow Petrochelidon pyrrhonota	R	S,F	X	X	X	X				X				X
Purple Martin Progne subis	C	S,Sm,F	X	X	X	X				X				X
*Blue Jay Cyanocitta cristata	A	R	X	X	X	X	X	X	X	X			X	
*Common Crow Corvus brachyrhynchos	A	R	X	X	X	X	X	X	X	X				
*Fish Crow Corvus ossifragus	C	R	X	X	X	X	X	X	X	X				X
*Carolina Chickadee Parus carolinensis	C	R					X	X					X	
*Tufted Titmouse Parus bicolor	A	R			X		X	X					X	
Brown-headed Nuthatch Sitta pusilla	R	R				X								
*House Wren Troglodytes aedon	C	F,W,S	X		X	X	X	X	X	X		X	X	
*Carolina Wren Thryothorus ludovicianus	A	R	X		X	X	X	X	X	X		X	X	
Long-billed Marsh Wren Cistothorus palustris	U	F,W,S		X	X									X
Short-billed Marsh Wren Cistothorus platensis	C	F,W,S		X	X									X
*Mockingbird Mimus polyglottos	A	R	X	X	X	X								
Gray Catbird Dumetella carolinensis	C	F,W,S	X		X		X						X	
*Brown Thrasher Toxostoma rufum	C	R	X		X		X							
*American Robin Turdus migratorius	A	F,W,S	X	X	X	X							X	
*Wood Thrush Hylocichla mustelina	U	F,S					X	X					X	
Hermit Thrush Catharus guttata	U	F,W,S					X	X					X	
Swainson's Thrush Catharus ustulata	C	F,S					X	X					X	
Gray-cheeked Thrush Catharus minima	U	F,S					X	X					X	
Veery Catharus fuscescens	U	F,S	X	X	X		X							
Eastern Bluebird Sialia sialis	C	R	X		X	X	X	X	X	X			X	
*Blue-gray Gnatcatcher Polioptila caerulea	C	R	X		X	X	X	X	X	X			X	

TABLE 8-5 (Continued)

Species[1]	Abundance[2]	Season of Occurrence[3]	Habitat Association[4] 100	210	230	410	420	430	440	450	500	610	620	640
Ruby-crowned Kinglet *Regulus calendula*	C	F,W,S	X		X		X	X					X	
Water Pipit *Anthus spinoletta*	R	F,W,S		X	X									
Cedar Waxwing *Bombycilla cedrorum*	C	F,W,S	X		X		X	X					X	
*Loggerhead Shrike *Lanius ludovicianus*	C	R	X	X	X	X								
*Starling *Sturnus vulgaris*	R	R	X	X	X	X								
White-eyed Vireo *Vireo griseus*	C	R	X		X		X	X				X	X	
Yellow-throated Vireo *Vireo flavifrons*	C	S,F					X	X					X	
Solitary Vireo *Vireo solitarius*	U	S,W,F				X	X	X	X	X				
Red-eyed Vireo *Vireo olivaceus*	U	S,F				X	X	X	X	X			X	
*Black-and-White Warbler *Mniotilta varia*	C	S,W,F			X	X	X	X	X	X			X	
Prothonotary Warbler *Protonotaria citrea*	U	S,Sm,F											X	
Swainson's Warbler *Limnothlypis swainsonii*	R	S,F											X	
*Worm-eating Warbler *Helmitheros vermivorus*	R	S,F					X						X	
Tennessee Warbler *Vermivora peregrina*	U	S,W,F					X							
Orange-crowned Warbler *Vermivora celata*	U	S,W,F					X							
Northern Parula *Parula americana*	C	R				X	X	X	X	X		X	X	
Yellow Warbler *Dendroica petechia*	U	S,W,F	X	X	X								X	X
Magnolia Warbler *Dendroica magnolia*	U	S,F			X	X	X	X	X	X		X	X	
Cape May Warbler *Dendroica tigrina*	U	S,F			X	X	X	X	X	X		X	X	
Black-throated Blue Warbler *Dendroica caerulescens*	R	S,F			X	X	X	X	X	X		X	X	
*Yellow-rumped Warbler *Dendroica coronata*	A	S,W,F	X		X	X	X	X	X	X		X	X	
Black-throated Green Warbler *Dendroica virens*	R	S,F			X	X	X	X	X	X		X	X	
Blackburnian Warbler *Dendroica fusca*	U	S,F			X	X	X	X	X	X		X	X	
*Yellow-throated Warbler *Dendroica dominica*	C	R			X	X	X	X	X	X		X	X	
Blackpoll Warbler *Dendroica striata*	U	S,W,F			X	X	X	X	X	X		X	X	
*Pine Warbler *Dendroica pinus*	C	R			X	X	X	X	X	X		X	X	
Prairie Warbler *Dendroica d. discolor*	C	S,W,F	X	X	X	X	X	X	X	X		X	X	
*Palm Warbler *Dendroica palmarum*	A	S,W,F	X	X	X	X	X	X	X	X		X	X	
Ovenbird *Seiurus aurocapillus*	U	S,W,F					X						X	
Northern Waterthrush *Seiurus noveboracensis*	U	S,F					X						X	
Louisiana Waterthrush *Seiurus motacilla*	R	S,F	X	X	X							X	X	X
*Common Yellowthroat *Geothlypis trichas*	A	R					X					X	X	
Hooded Warbler *Wilsonia citrina*	U	S,F			X	X	X	X	X	X		X	X	
American Redstart *Setophaga r. ruticilla*	G	S,W,F	X	X	X									
House Sparrow *Passer domesticus*	R	R	X	X		X								
Bobolink *Dolichonyx oryzivorus*	U	S,W,F	X	X		X								

TABLE 8-5 (Continued)

Species[1]	Abundance[2]	Season of Occurrence[3]	Habitat Association[4] 100	210	230	410	420	430	440	450	500	610	620	640
*Eastern Meadowlark *Sturnella magna*	A	R	X	X	X								X	X
*Red-winged Blackbird *Agelaius phoeniceus*	A	R	X	X	X							X	X	X
Orchard Oriole *Icterus spurius*	C	S,F			X		X	X						
Northern Oriole *Icterus galbula*	U	S,F			X		X	X						
Rusty Blackbird *Euphagus carolinus*	U	F,W,S		X	X								X	
Brewer's Blackbird *Euphagus cyanocephalus*	R	F,W,S		X	X									
Boat-tailed Grackle *Quiscalus major*	R	R		X								X	X	X
Common Grackle *Quiscalus quiscula*	A	R	X	X	X		X	X					X	
Brown-headed Cowbird *Molothrus ater*	C	F,W,S	X	X	X									
Scarlet Tanager *Piranga olivacea*	U	F,S			X		X	X						
Summer Tanager *Piranga rubra*	U	F,S			X	X	X	X	X	X				
*Cardinal *Cardinalis cardinalis*	A	R	X		X	X							X	
Rose-breasted Grosbeak *Pheucticus ludovicianus*	U	F,S					X	X						
Blue Grosbeak *Guiraca caerulea*	C	F,Sm,S		X	X		X	X						
Indigo Bunting *Passerina cyanea*	C	F,S		X		X								
Painted Bunting *Passerina ciris*	N	F,W,S		X	X	X								
Dickcissel *Spiza americana*	N	F,W,S		X	X	X								
American Goldfinch *Carduelis tristis*	C	F,W,S		X	X	X	X	X	X	X		X	X	
*Rufous-sided Towhee *Pipilo erythrophthalmus*	A	R		X	X	X								
Savannah Sparrow *Passerculus sandwichensis*	A	F,W,S		X	X	X								
Leconte's Sparrow *Ammospiza leconteii*	N	F,W,S		X	X	X								
Vesper Sparrow *Pooecetes gramineus*	C	F,W,S				X								
Bachman's Sparrow *Aimophila aestivalis*	U	R		X	X	X	X	X	X	X			X	
Chipping Sparrow *Spizella passerina*	A	F,W,S		X	X	X	X	X	X	X			X	
Field Sparrow *Spizella pusilla*	C	F,W,S		X	X	X	X	X	X	X			X	
White-crowned Sparrow *Zonotrichia leucophrys*	R	F,W,S		X	X	X	X	X	X	X				
White-throated Sparrow *Zonotrichia albicollis*	C	F,W,S		X	X	X								X
Lincoln's Sparrow *Melospiza lincolnii*	N	F,W,S		X	X	X								X
Swamp Sparrow *Melospiza georgiana*	A	F,W,S		X	X	X								X
Song Sparrow *Melospiza melodia*	C	F,W,S		X	X	X								X

Source: Study Data

[1] * = animal observed on site

[2] A = Abundant = frequently observed
C = Common = often observed
U = Uncommon = infrequently observed
R = Rare = very infrequently observed
N = Not Expected

[3] F = Fall
W = Winter
S = Spring
Sm = Summer
R = Resident

[4] Level III categories from the *Florida Land Use and Cover Classification System: A Technical Report* (1977).

TABLE 8-6

OCCURRENCE AND RELATIVE ABUNDANCE OF REPTILES ON THE SOUTH FORT MEADE MINE SITE

Species[1]	Abundance[2]	Season of Occurrence[3]	Habitat Association[4]											
			100	210	230	410	420	430	440	450	500	610	620	640
*American Alligator Alligator mississippiensis	C	R									X	X	X	X
Snapping Turtle Chelydra serpentina	C	R									X			X
Stinkpot Sternotherus odoratus	C	R									X	X	X	X
*Mud Turtle Kinosternon s. subrubrum	U	R									X	X	X	X
Striped Mud Turtle Kinosternon bauri palmarum	C	R									X	X	X	X
Box Turtle Terrapene carolina	C	R		X		X	X	X	X	X		X	X	X
*Peninsula Cooter Chrysemys floridana peninsularis	C	R									X	X	X	X
Florida Red-bellied Turtle Chrysemys nelsoni	C	R									X			X
*Chicken Turtle Deirochelys reticularia	C	R									X	X	X	X
*Gopher Tortoise Gopherus polyphemus	C	R			X	X	X	X	X	X				
*Florida Softshell Trionyx ferox	C	R									X			X
*Green Anole Anolis carolinensis	A	R	X	X	X	X	X	X	X	X		X	X	X
*Fence Lizard Sceloporus u. undulatus	U	R				X	X	X	X	X				
*Six-lined Racerunner Cnemidophorus sexlineatus	C	R		X	X	X								
*Ground Skink Leiolopisma laterale	C	R	X	X	X	X	X	X	X	X		X	X	X
*Southeastern Five-lined Skink Eumeces inexpectatus	C	R		X	X	X	X	X	X	X		X	X	X
Eastern Glass Lizard Ophisaurus ventralis	U	R	X	X	X	X	X	X	X	X		X	X	X
Slender Glass Lizard Ophisaurus attenuatus	R	R	X	X	X	X	X	X	X	X				
Island Glass Lizard Ophisaurus compressus	R	R				X								
Worm Lizard Rhineura floridana	U	R		X	X	X	X	X	X	X				
Green Water Snake Nerodia cyclopion	C	R									X	X	X	X
Brown Water Snake Nerodia taxispilota	U	R									X	X	X	
*Banded Water Snake Nerodia sipedon pictiventris	A	R									X	X	X	X
Striped Swamp Snake Liodytes alleni	C	R									X	X	X	X
Black Swamp Snake Seminatrix pygaea	U	R									X	X	X	X
Brown Snake Storeria dekayi	R	R				X					X	X	X	X
*Garter Snake Thamnophis sirtalis	C	R	X		X	X	X	X	X	X	X	X	X	X

TABLE 8-6 (Continued)

Species[1]	Abundance[2]	Season of Occurrence[3]	Habitat Association[4] 100	210	230	410	420	430	440	450	500	610	620	640
Ribbon Snake *Thamnophis sauritus*	A	R	X		X	X	X	X	X	X	X	X	X	X
Eastern Hognose Snake *Heterodon platyrhinos*	U	R			X	X	X	X	X	X				
Southern Hognose Snake *Heterodon simus*	R	R	X			X								
Ringneck Snake *Diadophis punctatus*	C	R	X		X	X	X	X	X	X	X	X	X	X
Pine Woods Snake *Rhadinaea flavilata*	R	R				X						X	X	
Mud Snake *Farancia abacura*	C	R									X	X	X	X
*Black Racer *Coluber constrictor*	A	R	X	X	X	X	X	X	X	X		X	X	X
Coachwhip *Masticophis flagellum*	U	R		X	X	X	X	X	X	X				
*Rough Green Snake *Opheodrys aestivus*	U	R	X		X	X	X	X	X	X	X			X
*Eastern Indigo Snake *Drymarchon corais couperi*	U	R			X	X	X	X	X	X		X	X	
Corn Snake *Elaphe guttata*	U	R	X	X	X	X	X	X	X	X		X	X	
*Yellow Rat Snake *Elaphe obsoleta quadrivittata*	C	R	X	X	X	X	X	X	X	X	X	X	X	X
Pine Snake *Pituophis melanoleucus*	U	R			X	X	X	X	X	X				
*Kingsnake *Lampropeltis getulus*	C	R				X	X	X	X	X	X	X	X	X
Scarlet Kingsnake *Lampropeltis triangulum*	R	R			X	X	X	X	X	X	X	X	X	
Scarlet Snake *Cemophora coccinea*	R	R				X	X	X	X	X				
Short-tailed Snake *Stilosoma extenuatum*	N	R				X	X	X						
Florida Crowned Snake *Tantilla relicta*	R	R				X	X	X	X	X			X	
Coral Snake *Micrurus fulvius*	U	R			X	X	X	X	X	X		X	X	
Cottonmouth *Agkistrodon piscivorus*	C	R		X		X	X	X	X	X	X	X	X	X
Pygmy Rattlesnake *Sistrurus miliarius*	U	R		X		X	X	X	X	X	X	X	X	X
*Eastern Diamondback Rattlesnake *Crotalus adamanteus*	C	R		X	X	X	X	X	X	X				

Source: Study Data

[1] * = animal observed on site

[2] A = Abundant = frequently observed
C = Common = often observed
U = Uncommon = infrequently observed
R = Rare = very infrequently observed
N = Not Expected

[3] F = Fall
W = Winter
S = Spring
Sm = Summer
R = Resident

[4] Level III categories from the *Florida Land Use and Cover Classification System: A Technical Report* (1977).

TABLE 8-7

OCCURRENCE AND RELATIVE ABUNDANCE OF AMPHIBIANS ON THE SOUTH FORT MEADE MINE SITE

Species[1]	Abundance[2]	Season of Occurrence[3]	Habitat Association[4]											
			100	210	230	410	420	430	440	450	500	610	620	640
Two-toed Amphiuma *Amphiuma means*	C	R									X	X	X	X
Greater Siren *Siren lacertina*	C	R									X	X	X	X
Lesser Siren *Siren intermedia*	C	R									X	X	X	X
Dwarf Siren *Pseudobranchus striatus*	C	R									X	X	X	X
Peninsula Newt *Notophthalmus viridescens*	U	R					X				X	X	X	X
Southern Dusky Salamander *Desmognathus auriculatus*	N	R					X				X	X	X	
*Slimy Salamander *Plethodon glutinosus*	R	R					X				X	X	X	
Dwarf Salamander *Eurycea quadridigitata*	U	R									X	X	X	X
Eastern Spadefoot Toad *Scaphiopus holbrooki*	C	R				X	X	X	X	X	X	X	X	X
*Greenhouse Frog *Eleutherodactylus planirostris*	A	R			X	X	X				X	X	X	X
*Southern Toad *Bufo terrestris*	A	R	X	X	X	X	X	X	X	X	X	X	X	X
*Oak Toad *Bufo quercicus*	C	R	X	X	X	X	X	X	X	X	X	X	X	X
*Southern Cricket Frog *Acris gryllus*	A	R	X								X	X	X	X
*Green Treefrog *Hyla cinerea*	A	R	X		X						X	X	X	X
Barking Treefrog *Hyla gratiosa*	U	R	X		X	X	X	X	X	X	X	X	X	X
Pine Woods Treefrog *Hyla femoralis*	A	R				X	X	X	X	X	X	X	X	X
Squirrel Treefrog *Hyla squirella*	A	R	X		X	X	X	X	X	X	X	X	X	X
*Little Grass Frog *Limnaoedus ocularis*	A	R	X			X	X	X	X	X	X	X	X	X
Chorus Frog *Pseudacris nigrita*	U	R				X					X	X	X	X
*Eastern Narrow-mouthed Toad *Gastrophryne carolinensis*	C	R	X		X	X	X	X	X	X	X	X	X	X
Bullfrog *Rana catesbeiana*	C	R									X	X	X	X
*Pig Frog *Rana grylio*	C	R									X	X	X	X
*Southern Leopard Frog *Rana sphenocephala*	A	R				X					X	X	X	X
Florida Gopher Frog *Rana areolata aesopus*	R	R				X	X				X			X

Source: Study Data

[1]* = animal observed on site

[2]A = Abundant = frequently observed
C = Common = often observed
U = Uncommon = infrequently observed
R = Rare = very infrequently observed
N = Not Expected

[3]F = Fall
W = Winter
S = Spring
Sm = Summer
R = Resident

[4]Level III categories from the *Florida Land Use and Cover Classification System: A Technical Report* (1977).

TABLE 8-8

OCCURRENCE AND RELATIVE ABUNDANCE OF ALGAE IN THE PEACE RIVER BASIN

Algae	Abundance
XANTHOPHYTA	
Vaucheria	O
Tribonema	U
Bumillaria	R
CRYPTOPHYTA	
Rhodomonas	A
Cryptomonas	C
Chroomonas	C
Monomastix	R
CHAROPHYTA	
Chara	O
CYANOPHYTA	
Oscillatoria	A
Agmenellum	C
Lyngbya	C
Microcystis	C
Anabaena	O
Aphanocapsa	O
Phormidium	U
Schizothrix	U
Spirulina	U
Calothrix	U
Pleurocapsaceae (unspecified)	U
Chroococcus	O
Aphanothece	U
CHLOROPHYTA	
Scenedesmus	A
Rhizoclonium	A
Chlamydomonas	A
Ankistrodesmus	C
Spermatozoopsis	C
Oocystis	O
Closterium	O
Crucigenia	O
Pediastrum	O
Cladophora	O
Cosmarium	O
Gleocystis	O
Tetraedron	O
Spirogyra	O
Oedogonium	U
Mougeotia	R
Actinastrum	U
Sphaerocystis	U
Eudorina	U
Kirschneriella	U
Micractinium	U
Coelastrum	U
Ulothrix	U
Chaetophorales (unspecified)	U
Tetrastrum	R
Tetraspora	R
Characium	R
Hydrodictyon	R
Hormidium	R
Protoderma	R
Entocladia	R
Gonium	R
Quadrigula	R
Dictyosphaerium	R
Shroederia	U
Xanthidium	P
BACILLARIOPHYTA	
Nitzchia	C
Navicula	C
Fragillaria	A
Opephora	A
Melosira	C
Cocconeis	C
Pinnularia	O
Cyclotella	C
Gomphonema	O
Achnanthes	C
Eunotia	U
Cymbella	O
Bacillaria	O
Synedra	U
Gyrosigma	U
Amphiprora	P
Amphora	O
Frustulia	U
Surirella	U
Diploneis	O
Diatoma	U
Dimerogramma	U
Thallassiosira	O
Neidium	U
Skeletonema	U
Microsiphona	U
Aphora	U
Terpsinoe	P
Meridion	R
Campyloneis	R
Pleurosigma	R
Denticula	R
Cymatopleura	R
Caloneis	R
Capartogramma	R
Coscinodisus	R
Stephanodisus	R
Cymatosira	R
Desmogonium	R
Mastogloia	R
Epithemia	R
Stauroneis	P
Rhoicospheria	P
CHRYSOPHYTA	
Mallomonas	U
Dinobryon	U
Rhizochrysidales (unspecified)	U
Isochrysidales (unspecified)	R
Monosigales (unspecified)	R
Desmarella	R
Monosiga	R
EUGLENOPHYTA	
Euglena	O
Phaeus	U
Trachelomonas	U
Lepocinclis	R
PYRRHOPHYTA	
Peridinium	C
Gonyaulax	C
Ceratium	O
Gymnodinium	U

Source: EPA,1978

Key: A = Abundant
C = Common
O = Occasional
U = Uncommon
R = Rare
P = Present, but with no indication of abundance

TABLE 8-9

OCCURRENCE AND RELATIVE ABUNDANCE OF AQUATIC MACROPHYTES IN THE PEACE RIVER BASIN

Taxon	Abundance
Water hyacinth (*Eichhornia crassipes*)	C
Rush (*Juncus* spp.)	C
Panic grass (*Panicum* spp.)	C
Smartweed (*Polygonum* spp.)	C
Pickerelweed (*Pontedaria lanceolata*)	O
Yellow pond lily (*Nuphar luteum*)	O
Water pennywort (*Hydrocotyle umbellata*)	C
Duckweed (*Lemna* spp.)	C
Cattail (*Typha* sp.)	O
Water primrose (*Ludwigia repens*)	A
False loosestrife (*Ludwigia peruviana*)	A
Water purslane (*Ludwigia* sp.)	O
Eelgrass (*Vallisneria neotropicalis*)	C
Southern naiad (*Najas quadalupersis*)	C
Spike rush (*Eleocharis* spp.)	O
Hydrilla (*Hydrilla verticillata*)	P
Water fern (*Salvinia rotundifolia*)	O
Aquatic moss (*Leptodictyum* sp.)	P
Pondweed (*Potamogeton* spp.)	C
Water grass (*Hydrochlora carolinensis*)	U
Arrowhead (*Sagittaria* spp.)	O
Water lettuce (*Pista stratiotes*)	O
Alligator weed (*Alternanthera philoxeroides*)	C
Widgeon grass (*Ruppia maritima*)	C
Shoal grass (*Halodule* spp.)	C
Bulrush (*Scirpus conferuoides*)	C
Dock (*Rumex* spp.)	C
St. John's wort (*Hypericum boreale*)	P
American frog's-bit (*Lumnobium spongia*)	O
Cape weed (*Lippia nodiflora*)	O
Water hyssop (*Bacopa monnieri*)	O
Wild orchid (*Habenaria* sp.)	O
Floating heart (*Nymphoides* sp.)	O
Micranthemum (*Micranthemum umbrosum*)	O
Bog moss (*Mayaca* sp.)	U
Thalia (*Thalia geniculata*)	U

SOURCE: EPA, 1978

Key:
A = Abundant
C = Common
O = Occasional
U = Uncommon
R = Rare
P = Present, but with no indication of abundance

TABLE 8-10

BENTHIC MACROINVERTEBRATES COLLECTED BY PONAR GRAB FROM THE PEACE RIVER DURING SEPTEMBER (S) AND DECEMBER (D) 1979

Taxon	Stations/Replicates																	
	M3						M4						M5					
	A		B		C		A		B		C		A		B		C	
	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D
PLATYHELMINTHES																		
Turbellaria	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	0	0	0
ANNELIDA																		
Oligochaeta																		
Achaeta sp. (Enchytraeidae)	0	0	0	0	-	1	0	0	0	0	0	0	0	0	0	0	0	0
Limnodrilus hoffmeisteri	0	0	0	0	-	2	0	3	0	3	0	6	0	3	0	18	0	15
Lumbriculidae	0	0	0	0	-	0	0	0	0	0	0	0	0	1	0	1	0	1
Tubificidae	1	0	2	0	-	0	0	0	0	0	0	0	1	0	0	1	0	0
Hirudinea																		
Unidentified sp.	0	0	0	0	-	0	0	0	0	1	0	0	0	0	0	0	0	0
MOLLUSCA																		
Gastropoda																		
Ferressia sp.	0	0	0	1	-	0	0	0	0	1	0	0	0	0	0	0	0	0
Bivalvia																		
Corbicula manilensis	0	0	0	0	-	0	7	28	9	18	9	113	3	0	2	1	1	0
ARTHROPODA																		
Insecta																		
Ephemeroptera																		
Cleon sp.	0	0	0	0	-	1	0	1	0	0	0	1	0	0	0	0	0	0
Unidentified sp.	0	0	0	0	-	0	0	0	0	1	0	0	0	0	0	0	0	0
Odonata																		
Dromogomphus sp. (near)	0	0	0	0	-	1	0	0	0	0	0	0	0	0	0	0	0	0
Gomphus sp. (near pallidus)	0	0	0	2	-	3	0	2	0	0	0	0	0	1	0	3	0	5
Macromia illinoiensis	0	0	0	0	-	0	0	0	0	1	0	0	0	0	0	1	0	1
Coleoptera																		
Dubiraphia sp.	0	0	0	2	-	0	0	2	0	3	0	2	0	0	0	2	0	4
Stenelmis sp.	0	0	0	0	-	0	0	0	0	0	0	0	1	0	0	0	0	0
Trichoptera																		
Cheumatopsyche sp.	0	0	0	0	-	0	0	0	0	0	0	0	1	0	0	0	0	0
Hydropsyche sp.	0	0	0	0	-	1	0	0	0	0	0	0	0	0	0	0	0	0
Nectopsyche sp.	0	0	0	0	-	0	0	1	0	5	0	5	0	0	0	0	0	0
Ochrotrichia sp.	0	0	0	1	-	0	0	2	0	0	0	1	0	0	0	1	0	0
Oecetis sp.	0	0	0	1	-	2	0	14	0	18	0	5	0	0	0	3	0	0
Diptera																		
Ceratopogonidae																		
Unidentified spp.	1	6	0	6	-	9	7	19	1	53	0	27	39	5	9	36	34	17
Chironomidae																		
Ablabesmyia parajanta	0	0	0	0	-	0	0	0	0	1	0	0	0	0	0	0	0	0
Ablabesmyia tarella	0	0	0	0	-	1	1	0	0	3	0	0	0	0	0	0	0	0
Chironomus sp.	0	0	0	0	-	2	0	0	0	0	0	0	0	0	0	0	0	0
Cladotanytarsus sp.	0	36	0	0	-	42	0	30	0	16	0	24	0	0	0	16	0	2
Cladopelma sp.	0	0	0	0	-	3	0	9	0	19	0	11	0	0	0	11	0	1
Clinotanytarsus sp.	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	7	0	0
Conchapelopia sp.	0	0	0	0	-	0	0	0	0	0	0	2	0	0	0	0	0	0
Corynoneura sp.	0	0	0	0	-	0	0	0	0	0	0	2	0	0	0	0	0	0
Corynoneura sp. (near)	0	0	0	0	-	2	13	0	1	0	1	2	0	0	0	0	0	0
Cricotopus sp.	0	0	0	0	-	0	0	1	0	3	0	1	0	0	0	0	0	0
Cryptochironomus (c.f. rolli)	0	0	0	0	-	1	0	0	0	0	0	0	0	0	0	0	0	0
Cryptochironomus fulvus	0	0	0	0	-	0	0	18	0	14	0	32	1	0	0	4	0	1
Cryptochironomus (near fulvus)	0	4	0	0	-	6	0	0	0	3	0	4	0	0	0	0	0	0
Labrundinea floridana	0	0	0	0	-	0	0	0	0	0	0	1	0	0	0	0	0	0
Micropsectra sp.	0	10	0	0	-	28	0	129	0	0	0	0	0	0	0	0	0	0
Nilodorum devineyae	0	0	0	0	-	0	0	0	0	80	0	186	0	4	0	9	0	21
Nilothauma sp.	0	0	0	0	-	0	0	0	0	4	0	6	0	0	0	1	0	0
Polypedilum sp. (near convictum)	0	0	0	0	-	0	0	47	0	6	0	7	2	0	0	1	0	0
Polypedilum halterale	0	28	0	0	-	9	1	1	0	25	0	77	2	0	10	7	0	2
Procladius sp.	0	0	0	0	-	2	0	2	0	4	0	5	0	0	0	26	0	5
Rheotanytarsus sp.	0	4	0	0	-	1	0	0	0	1	0	1	0	0	0	0	0	0
Robackia demijera	1	0	0	0	-	1	0	0	2	0	0	1	4	3	1	4	0	5
Sergentia sp.	0	0	0	0	-	0	0	1	0	0	0	0	0	0	0	0	0	0
Stenochironomus aestivalis	0	2	0	0	-	9	0	0	0	2	0	6	0	0	0	2	0	0
Stenorthocladius sp.	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribelos fuscicornis	0	0	0	0	-	2	0	0	0	0	0	3	0	0	0	0	0	3
Empididae																		
Unidentified spp.	0	0	0	0	-	0	0	0	0	0	0	0	0	1	0	2	0	0
Tabanidae																		
Chrysops sp.	0	0	0	1	-	0	0	0	0	1	0	0	0	0	0	0	0	0

SOURCE: STUDY DATA

TABLE 8-11

PEACE RIVER BENTHIC MACROINVERTEBRATE COMMUNITY CHARACTERISTICS FOR SEPTEMBER (S) AND DECEMBER (D) 1979

Station/Replicate		Species Richness[1]		Total Organisms		Species Density[2]		Species Diversity[3]		Equitability[4]		Florida Index[5]		Percentage Oligomixity[6]		Faunal Similarity[7]
		S	D	S	D	S	D	S	D	S	D	S	D	S	D	between seasons
M1	A	12	21	108	744	733	5343	1.55	2.26	0.31	0.31	2	8	75.3	43.3	0.43
	B	7	17	187	532	1342	3819	0.67	2.49	0.26	0.45	1	9	88.8	45.3	0.47
	C	10	13	145	295	1040	2117	0.72	2.00	0.14	0.41	1	7	90.4	60.4	0.61
	Pooled	16	26	440	1571	1038	3760	1.04	2.47	0.15	0.29	2	10	86.1	40.8	-
M2	A	4	7	74	476	531	3419	0.65	2.20	0.45	0.88	1	4	88.0	45.6	0.47
	B	3	9	85	244	610	1752	0.25	1.09	0.44	0.28	1	6	96.6	82.0	0.82
	C	5	20	109	755	783	5423	0.49	2.44	0.32	0.37	0	7	92.7	51.7	0.53
	Pooled	8	23	268	1475	641	3531	0.50	2.35	0.20	0.30	2	8	92.6	54.7	-
M6	A	1	15	88	149	632	1068	0.00	2.06	-	0.37	0	3	100.0	65.9	0.66
	B	1	8	38	254	273	1824	0.00	2.14	-	0.73	0	2	100.0	47.3	0.47
	C	1	8	204	124	1465	889	0.00	0.88	-	0.27	0	2	100.0	87.3	0.87
	Pooled	1	18	330	527	790	1260	0.00	2.08	-	0.31	0	3	100.0	61.9	-

SOURCE: STUDY DATA

[1] no. of taxa
[2] no./m^2
[3] Shannon-Weaver
[4] MacArthur's Broken Stick Model
[5] indicator organisms [(2 x Class I) + Class II]
[6] dominance by a single taxon
[7] Czekanowski's Index

TABLE 8-12

FAUNAL SIMILARITY (CZEKANOWSKI'S INDEX)
BETWEEN PEACE RIVER, BOWLEGS CREEK AND GILSHEY BRANCH STATIONS
(POOLED REPLICATES)

	Peace River			Bowlegs Creek			Gilshey Branch
	M1	M2	M6	M3	M4	M5	M8
September							
M1	--	0.90	0.86	0.04	0.48	0.09	0.21
M2	--	--	0.93	0.05	0.48	0.06	0.05
M6	--	--	--	0.00	0.48	0.05	0.00
M3	--	--	--	--	0.15	0.26	0.24
M4	--	--	--	--	--	0.22	0.04
M5	--	--	--	--	--	--	0.12
December							
M1	--	0.61	0.54	0.11	0.29	0.18	0.34
M2	--	--	0.69	0.03	0.21	0.13	0.16
M6	--	--	--	0.06	0.23	0.04	0.08
M3	--	--	--	--	0.42	0.28	0.39
M4	--	--	--	--	--	0.42	0.35
M5	--	--	--	--	--	--	0.18

SOURCE: STUDY DATA

TABLE 8-13

FISH SPECIES OF SOUTHERN POLK COUNTY, FLORIDA

Common Name	Scientific Name
Florida gar	Lepisosteus platyrhincus
Tarpon	Megalops atlantica
Threadfin shad	Dorosoma petenense
Channel catfish	Ictalurus punctatus
White catfish	Ictalurus catus
Brown bullhead	Ictalurus nebulosus
Yellow bullhead	Ictalurus natalis
Tadpole madtom	Noturus gyrinus
Walking catfish	Clarias batrachus
Lake chubsucker	Erimyzon sucetta
Golden shiner	Notemigonus crysoleucas
Pugnose minnow	Notropis emiliae
Coastal shiner	Notropis petersoni
Ironcolor shiner	Notropis chalybaeus
Taillight shiner	Notropis maculatus
American eel	Anguilla rostrata
Atlantic needlefish	Strongylura marina
Bluefin killifish	Lucania goodei
Seminole killifish	Fundulus seminolis
Golden topminnow	Fundulus chrysotus
Mosquitofish	Gambusia affinis
Least killifish	Heterandria formosa
Sailfin molly	Poecilia latipinna
Largemouth bass	Micropterus salmoides
Warmouth	Lepomis gulosus
Spotted sunfish	Lepomis punctatus
Redear sunfish	Lepomis microlophus
Bluegill	Lepomis macrochirus
Dollar sunfish	Lepomis marginatus
Bluespotted sunfish	Enneacanthus gloriosus
Black crappie	Pomoxis nigromaculatus
Swamp darter	Etheostoma fusiforme
Blue tilapia	Tilapia aurea
Brook silverside	Labidesthes sicculus
Tidewater silverside	Menidia beryllina

Source: Carter R. Gilbert, Ph.D.
Florida State Museum, Gainesville, Florida

TABLE 8-14

BENTHIC MACROINVERTEBRATES COLLECTED BY PONAR GRAB FROM BOWLEGS CREEK DURING SEPTEMBER (S) AND DECEMBER (D) 1979

Taxon	Stations/Replicates																	
	M1						M2						M6					
	A		B		C		A		B		C		A		B		C	
	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D
PLATYHELMINTHES																		
Turbellaria	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0
NEMATODA																		
Unidentified spp.	1	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANNELIDA																		
Oligochaeta																		
Aulophorus sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Branchiura sowerbyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnodrilus hoffmeisteri	0	322	0	74	0	32	0	68	0	17	0	72	0	5	0	0	0	0
Pristina sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1
Tubificidae	3	0	15	0	1	0	7	0	2	0	5	0	0	0	0	0	0	0
Hirudinea																		
Unidentified spp.	0	6	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
MOLLUSCA																		
Gastropoda																		
Amnicola dalli johnsoni	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Ferressia sp.	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Pseudosuccinea	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia																		
Corbicula manilensis	81	222	166	241	131	178	65	217	82	200	101	390	88	98	38	120	204	108
Sphaerium sp.	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unionidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ARTHROPODA																		
Crustacea																		
Amphipoda																		
Hyallela azteca	0	1	0	1	5	1	0	0	0	0	0	47	0	1	0	0	0	0
Insecta																		
Ephemeroptera																		
Caenis diminuta	2	0	0	8	2	2	0	0	0	0	1	17	0	1	0	0	0	0
Cleon sp.	1	0	0	0	0	0	0	0	0	0	0	2	0	4	0	0	0	3
Stenonema sp.	2	0	0	0	1	0	0	0	0	0	0	9	0	0	0	1	0	0
Unidentified sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata																		
Gomphus sp. (near *pallidus*)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Gomphus sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macromia illinoiensis	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Negomphoides ambigua	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera																		
Dineutus sp.	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Dubiraphia sp.	0	1	0	4	0	0	0	0	0	0	0	5	0	1	0	0	0	0
Stenelmis sp.	2	1	0	12	1	0	1	41	0	14	0	134	0	1	0	36	0	2
Neuroptera																		
Corydalus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
Trichoptera																		
Cheumatopsyche sp.	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Cyrnellus sp.	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0
Hydropsyche sp.	8	4	0	49	0	9	0	0	0	0	0	0	0	13	0	43	0	2
Diptera																		
Ceratopogonidae																		
Unidentified spp.	0	4	0	2	0	0	0	9	0	0	1	0	0	6	0	0	0	5
Chironomidae																		
Ablabesmyia mallochi	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
Chironomus sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corynoneura sp.	0	2	0	1	0	3	0	9	0	1	0	5	0	0	0	0	0	0
Corynoneura sp. (near)	0	2	0	1	0	1	0	41	0	3	0	20	0	0	0	0	0	0
Cryptochironomus fulvus	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0
Cryptochironomus sp. (near)	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Glyptotendipes sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropsectra sp.	0	25	0	8	0	1	0	0	0	0	0	2	0	4	0	0	0	0
Paramerina sp. (near)	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Polypedilum sp. (near)	5	79	1	88	1	35	0	91	0	4	0	14	0	2	0	21	0	1
Polypedilum halterale	0	54	0	30	0	19	0	0	0	2	0	3	0	2	0	0	0	0
Rheotanytarsus sp.	1	2	2	9	0	12	0	0	0	2	0	0	0	7	0	29	0	2
Empididae																		
Unidentified spp.	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	1	0	0

SOURCE: STUDY DATA

TABLE 8-15

BOWLEGS CREEK BENTHIC MACROINVERTEBRATE COMMUNITY CHATACTERISTICS FOR SEPTEMBER (S) AND DECEMBER (D) 1979

Station/Replicate		Species Richness[1]		Total Organisms		Species Density[2]		Species Diversity[3]		Equitability[4]		Florida Index[5]		Percentage Oligomixity[6]		Faunal Similarity[7]
		S	D	S	D	S	D	S	D	S	D	S	D	S	D	between seasons
M3	A	3	8	3	91	21	654	1.58	2.25	1.26	0.80	0	3	33.3	39.6	0.07
	B	1	8	2	15	14	106	0.00	2.59	-	1.03	0	4	100.0	40.6	0.00
	C	-	21	-	128	-	916	-	3.21	-	0.63	-	14	-	33.0	-
Pooled		3	27	18	234	18	559	1.37	3.20	1.07	0.48	0	14	60.0	33.5	0.09
M4	A	4	18	28	31	200	2224	1.68	2.79	1.02	0.53	5	7	46.5	41.7	0.15
	B	4	25	13	286	93	2051	1.33	3.46	0.77	0.63	2	12	69.9	28.0	0.25
	C	2	26	10	531	72	3811	0.46	3.00	0.78	0.43	2	9	90.3	35.1	0.21
Pooled		5	35	51	848	122	2695	1.73	3.27	0.85	0.39	7	18	49.3	35.1	0.25
M5	A	9	8	53	20	379	142	1.55	2.76	0.41	1.18	2	2	73.9	25.4	0.35
	B	3	22	12	160	86	1147	1.03	3.57	0.82	0.78	0	11	75.6	22.6	0.31
	C	2	14	35	88	251	631	0.18	3.16	0.61	0.91	0	8	97.2	23.9	0.20
Pooled		9	23	100	268	239	640	1.13	3.61	0.29	0.77	2	13	82.3	21.7	0.32

SOURCE: STUDY DATA

[1] no. of taxa
[2] no./m^2
[3] Shannon-Weaver
[4] MacArthur's Broken Stick Model
[5] indicator organisms [(2 x Class I) + Class II]
[6] dominance by a single taxon
[7] Czekanowski's Index

TABLE 8-16

FRESHWATER FISH COLLECTED FROM BOWLEGS CREEK
OCTOBER 29-30, 1979

	Station							
	F1		F2		F3		Pooled	
Species	No.	%	No.	%	No.	%	No.	%
Yellow bullhead *Ictalurus natalis*	0	0.0	30	13.2	0	0.0	30	6.7
Walking catfish *Clarias batrachus*	0	0.0	9	4.0	0	0.0	9	2.0
Lake chubsucker *Erimyzon sucetta*	0	0.0	7	3.1	0	0.0	7	1.6
Golden shiner *Notemigonus chrysoleucas*	6	5.0	7	3.1	0	0.0	13	2.9
Coastal shiner *Notropis petersoni*	0	0.0	0	0.0	12	12.1	12	2.7
Golden topminnow *Fundulus chrysotus*	0	0.0	1	0.4	24	24.1	25	5.6
Eastern mosquitofish *Gambusia affinis holbrooki*	49	41.2	25	11.0	8	8.1	82	18.4
Least killifish *Heterandria formosa*	0	0.0	8	3.5	4	4.0	12	2.7
Pirate perch *Aphredoderus sayanus*	0	0.0	1	0.4	0	0.0	1	0.2
Florida largemouth bass *Micropterus salmoides floridanus*	0	0.0	1	0.4	3	3.1	4	0.9
Warmouth *Lepomis gulosus*	1	0.8	12	5.3	2	2.0	15	3.4
Spotted sunfish *Lepomis punctatus*	9	7.6	22	9.7	3	3.1	34	7.6
Bluegill *Lepomis macrochirus*	4	3.4	74	32.6	8	8.1	86	19.4
Dollar sunfish *Lepomis marginatus*	2	1.7	16	7.2	16	16.2	34	7.6
Bluespotted sunfish *Enneacanthus gloriosus*	1	0.8	8	3.5	1	1.0	10	2.2
Everglades pygmy sunfish *Elassoma evergladei*	0	0.0	3	1.3	0	0.0	3	0.7
Southern swamp darter *Etheostoma fusiforme barratti*	0	0.0	1	0.4	0	0.0	1	0.2
Southern brook silverside *Labidesthes sicculus vanhyningi*	47	39.5	2	0.9	18	18.2	67	15.2
Total Number of Taxa	8		17		11		18	
Total Number of Organisms	119	100.0	227	100.0	99	100.0	445	100.0

SOURCE: STUDY DATA

TABLE 8-17

BENTHIC MACROINVERTEBRATES COLLECTED BY PONAR GRAB FROM GILSHEY BRANCH DURING SEPTEMBER (S) AND DECEMBER (D) 1979

Taxon	Stations/Replicates MB					
	A		B		C	
	S	D	S	D	S	D
NEMATODA						
Unidentified spp.	0	2	0	1	0	1
ANNELIDA						
Oligochaeta						
Aulophorus sp.	0	0	0	1	0	0
Limnodrilus hoffmeisteri	0	42	0	56	0	32
Tubificidae	3	0	7	0	7	0
MOLLUSCA						
Gastropoda						
Ferressia sp.	0	1	0	7	0	6
Physa sp.	0	0	0	4	0	3
Promenetes sp.	0	0	0	1	0	1
Bivalvia						
Eupera cubensis	0	0	0	1	0	1
Sphaerium sp.	4	21	2	25	11	3
Unionidae	0	0	0	0	1	0
ARTHROPODA						
Crustacea						
Isopoda						
Asellus sp.	0	0	0	1	0	0
Amphipoda						
Hyallela azteca	0	0	0	8	0	0
Decapoda						
Unidentified sp.	0	0	0	1	0	0
Insecta						
Ephemeroptera						
Caenis diminuta	2	0	0	33	1	19
Cleon sp.	0	6	0	7	0	1
Stenonema sp.	0	0	0	1	0	0
Unidentified sp.	0	0	0	1	0	0
Odonata						
Macronia illinoiensis	0	0	1	0	0	0
Nehalennia sp. A	0	0	0	1	0	0
Nehalennia sp. B	0	0	0	9	0	0
Zygoptera						
Agrion maculatum	0	0	0	9	0	2
Enallagma sp.	0	0	0	0	0	1
Coleoptera						
Dineutus sp.	2	0	0	1	0	0
Dibiraphia sp.	4	3	2	23	4	7
Oreodytes (Deronectes) sp.	0	0	0	3	0	1
Stenelmis sp.	1	0	0	2	0	0
Trichoptera						
Cheumatopsyche sp.	5	0	0	0	0	0
Hydropsyche sp.	0	15	1	65	0	23
Ochrotrichia sp.	0	0	0	2	0	0
Oecetis sp.	0	0	0	4	0	3
Diptera						
Ceratopogonidae						
Unidentified spp.	2	11	0	23	0	6
Chironomidae						
Ablabesmyia mallochi	0	0	0	1	0	0
Ablabesmyia tarella	0	0	0	26	0	9
Chironomus sp.	0	0	0	0	0	1
Cladotanytarsus sp.	1	16	0	34	0	19
Conchapelopia sp.	0	1	0	1	0	0
Corynoneura sp.	0	7	0	4	0	2
Corynoneura sp. (near)	1	0	0	0	0	0
Cricotopus bicinctus	0	0	0	3	0	3
Cryptochironomus (c.f. rolli)	0	4	0	18	1	11
Cryptochironomus fulvus	0	7	0	26	0	14
Kiefferulus dux	0	1	0	0	0	0
Labrundinea floridana	0	0	0	0	0	1
Micropsectra sp.	0	28	0	493	0	287
Nilodorum devineyae	0	0	0	1	0	0
Parachironomus (directus)	0	0	0	0	0	1
Polypedilum sp. (near convictum)	9	50	2	163	0	104
Polypedilum halterale	1	83	0	89	2	91
Polypedilum sp. (near illinoense)	0	1	0	3	0	4
Psectrocladius sp.	0	0	0	1	0	0
Rheotanytarsus sp.	0	12	0	73	0	45
Stenochironomus aestivalis	0	0	0	9	0	8
Tanytarsus sp.	1	0	0	0	0	0
Thienemanniella sp.	0	0	0	6	0	7
Tribelos fuscicornis	0	0	0	1	0	0
Simulidae						
Simulium sp.	0	0	0	1	0	0
Tabanidae						
Chrysops sp.	0	0	0	1	0	4

SOURCE: STUDY DATA

TABLE 8-18

GILSHEY BRANCH BENTHIC MACROINVERTEBRATE COMMUNITY CHATACTERISTICS FOR SEPTEMBER (S) AND DECMEBER (D) 1979

Station/Replicate		Species Richness[1]		Total Organisms		Species Density[2]		Species Diversity[3]	
		S	D	S	D	S	D	S	D
M8	A	13	19	36	311	257	2232	3.30	3.33
	B	6	46	15	1244	106	8931	2.19	3.41
	C	7	33	27	721	193	5174	2.24	3.17
	Pooled	17	52	78	2276	184	5446	3.26	3.45

Station/Replicate		Equitability[4]		Florida Index[5]		Percentage Oligomixity[6]		Faunal Similarity[7]
		S	D	S	D	S	D	between seasons
M8	A	1.08	0.76	4	5	25.3	26.7	0.34
	B	1.02	0.33	4	22	47.2	39.7	0.22
	C	0.91	0.39	1	19	40.9	39.9	0.19
	Pooled	0.80	0.30	9	25	21.9	35.5	0.28

[1] no. of taxa

[2] no./m^2

[3] Shannon-Weaver

[4] MacArthur's Broken Stick Model

[5] indicator organisms [(2 + Class I) + Class II]

[6] dominance by a single taxon

[7] Czekanowski's Index

SOURCE: STUDY DATA

TABLE 8-19

FRESHWATER FISH COLLECTED FROM TRIBUTARIES ON THE SOUTH FORT MEADE MINE SITE OCTOBER 29-30, 1979

Species	Station F4 No.	F4 %	F7 No.	F7 %	F8 No.	F8 %
Yellow bullhead *Ictalurus natalis*	1	50.0	0	0.0	0	0.0
Seminole killifish *Fundulus seminolis*	0	0.0	1	1.0	0	0.0
Eastern mosquitofish *Gambusia affinis holbrooki*	1	50.0	16	16.0	2	100.0
Least killifish *Heterandria formosa*	0	0.0	9	9.0	0	0.0
Sailfin molly *Poecilia latipinna*	0	0.0	34	34.0	0	0.0
Warmouth *Lepomis gulosus*	0	0.0	7	7.0	0	0.0
Spotted sunfish *Lepomis punctatus*	0	0.0	10	10.0	0	0.0
Dollar sunfish *Lepomis marginatus*	0	0.0	4	4.0	0	0.0
Everglades pygmy sunfish *Elassoma evergladei*	0	0.0	1	1.0	0	0.0
Southern swamp darter *Etheostoma fusiforme barratti*	0	0.0	15	15.0	0	0.0
Southern brook silverside *Labidesthes sicculus vanhyningi*	0	0.0	3	3.0	0	0.0
Total Number of Taxa	2		10		1	
Total Number of Organisms	2	100.0	100	100.0	2	100.0

SOURCE: STUDY DATA

TABLE 8-20

ENDANGERED, THREATENED AND RARE PLANTS OBSERVED ON THE SOUTH FORT MEADE MINE SITE

Species	Status[1]		
	State	REBF	Federal
Blechnum serrulatum Blechnum fern	T		
Cercis canadensis Eastern redbud	T		
Cornus florida Flowering dogwood	T		
Epidendrum conopseum Green-fly orchid	T		
Gordonia lasianthus Loblolly bay	T		
Ilex ambigua Carolina holly	T		
Ilex cassine Dahoon	T		
Ilex coriacea Large gallberry	T		
Ilex opaca American holly	T		
Ilex vomitoria Yaupon	T		
Lilium catesbaei Pine lily	T		
Lygodium japonicum Climbing fern	T		
Phlebodium aureum Golden polypody	T		
Polypodium polypodioides Resurrection fern	T		
Rhapidophyllum hystrix Needle palm	T	T	
Rhododendron serrulatum Swamp azalea	T		
Sabal minor Dwarf cabbage palm	T		
Sabal palmetto Cabbage palm	T		
Smilax smallii Small's greenbrier	T	T	
Thelypteris torresiana Thelypteris fern	T		
Tillandsia bartrami Bartram's air plant	T		
Woodwardia areolata Netted chain fern	T		
Woodwardia virginica Virginia chain fern	T		
Zephyranthes treatiae Zephyr lily	T	T	

[1] T = Threatened

Source: Study Data

State = Florida Statute 581.185, "Preservation of Native Flora of Florida"

REBF = Pritchard, P.C.H. and D.B. Ward, ed. (1978)

Federal = U.S. Fish and Wildlife Service (1976)

TABLE 8-21

BENTHIC MACROINVERTEBRATE STATION CONDITIONS

Station	System	Substrate	Water Depth (ft.)		Comments
			Sept.	Dec.	
M1	Peace River	Rocky, with coarse sand	6	<3	Vallisneria Occasional
M2	Peace River	Rocky, with coarse sand	6	<3	
M3	Bowlegs Creek	Coarse sand	4-5	~1.5	Cresting banks in Sept.
M4	Bowlegs Creek	Medium to fine sand	5-6	~1.5	Channelized; water at top of banks in Sept.
M5	Bowlegs Creek	Medium to fine sand	2-3	<1.5	
M6	Peace River	Fine sand overlying hard rock	8-10	3-6	
M8	Gilshey Branch	Gravel in midstream, coarse sand on bars, detritus and mud in pools	0.3-1.0	0.3-0.6	

SOURCE: STUDY DATA

TABLE 8-22

DISTURBED AND UNDISTURBED ACREAGE BY LAND USE AND COVER TYPE

Symbol	Land Use & Cover Type	Disturbed Acreage	Undisturbed Acreage	Percent Disturbed
111	Urban, single unit, low density	4	0	100
194	Abandoned mine piles	214	0	100
211	Row crops	810	0	100
212	Field crops	30	0	100
213	Improved pasture	6,768	108	98
231	Orange groves	566	0	100
4111	Cutover flatwoods, palmetto range	3,207	182	95
4121	Cutover longleaf pine/sandhill oaks	24	0	100
4221	Live oak, mixed understory	106	3	97
4222	Live oak, bahia understory	11	107	9
4223	Upland mesic	626	34	95
4224	Transition mesic (bottomland hardwoods)	397	520	43
431	Mixed forest	121	5	96
4411	Planted pine - no ground vegetation	17	0	100
4412	Planted pine - bahia ground cover	204	0	100
4413	Planted pine - flatwoods understory	118	0	100
451	Clearcut bayhead	39	0	100
531	Unvegetated reservoirs	3	0	100
560	Other water areas	0	3	0
563	Cattle water ponds	6	0	100
6111	Pond cypress, isolated	3	75	4
6211	Gum-maple swamp	163	22	88
6212	Bayhead	410	8	98
6213	Bay strand	23	0	100
6214	Myrtle thicket	15	6	71
6215	Mixed hardwood swamp	198	0	100
6221	Disturbed gum-maple swamp	8	0	100
6222	Disturbed bayhead	84	0	100
6411	Isolated upland depressions	869	14	98
6412	Wetland depressions	150	7	96
	TOTAL	15,194	1,094	93

SOURCE: STUDY DATA

TABLE 8-23

WASTE DISPOSAL ACREAGE

LAND TYPE	CONVENTIONAL CASE	SAND/CLAY CAP CASE	SAND/CLAY MIX CASE	OVERBURDEN/CLAY MIX CASE
Clay Settling (no cap)	6,681	--	1,642	--
Clay capped with Sand Tailings	1,489	--	--	--
Clay capped with Overburden		590		
Clay capped with Sand/Clay Mix (4:1)	--	7,580	--	--
Clay capped with Sand/Clay Mix (2:1)	--	--	3,185	2,847
Sand/Clay Mix or Overburden/Clay Mix (2:1)			3,512	5,492
Overburden Fill Plant Site and Graded Spoil	477	432	1,740	1,740
Sand Tailings Capped with Overburden	5,034	5,079	3,020	3,020
Water (Below-grade Clay Settling Areas)	1,513	1,513	2,095	2,095
Total	15,194	15,194	15,194	15,194

SOURCE: STUDY DATA

TABLE 8-24

ACREAGES BY LAND USE AND COVER CLASSIFICATIONS FOR RECLAMATION PLANS

Reclamation Case	Agricultural	Cutover Flatwoods and Bayhead	Upland Hardwood Forest	Upland Mixed Forest	Planted Pine	Water Areas	Forested Stream Channel**	Freshwater Swamp	Freshwater Marsh	TOTAL
Existing	8282	3452	1804	126	339	12	**	1,015	1,040	16,288*
(Proposed Action)										
Reclaimed	11,413	0	0	1,271	453	0	277	478	1,302	15,194
Undisturbed	108	182	664	5	0	3	0	111	21	1,094
TOTAL	11,521	182	664	1276	453	3	277	589	1,323	16,288
Sand/Clay Cap										
Reclaimed	11,003	0	0	1,451	536	0	279	504	1,421	15,194
Undisturbed	108	182	664	5	0	3	0	111	21	1,094
TOTAL	11,111	182	664	1,456	536	3	279	615	1,442	16,288
Sand/Clay Mix										
Reclaimed	10,313	0	0	1,826	431	0	263	746	1,615	15,194
Undisturbed	108	182	664	5	0	3	0	111	21	1,094
TOTAL	10,421	182	664	1,831	431	3	263	857	1,636	16,288
Overburden Mix	Similar to sand/clay mix case									

---

* Includes 4 acres of residential land and 214 acres of abandoned mine.

** This term is not used in describing the existing (premining) case. For the reclamation cases, this term applies to the 200-ft wide reforested area, associated with the 60,000 lineal feet of recreated stream channels.

SOURCE: STUDY DATA

9.0 HUMAN RESOURCES

9.1 THE AFFECTED ENVIRONMENT

9.1.1 DEMOGRAPHY

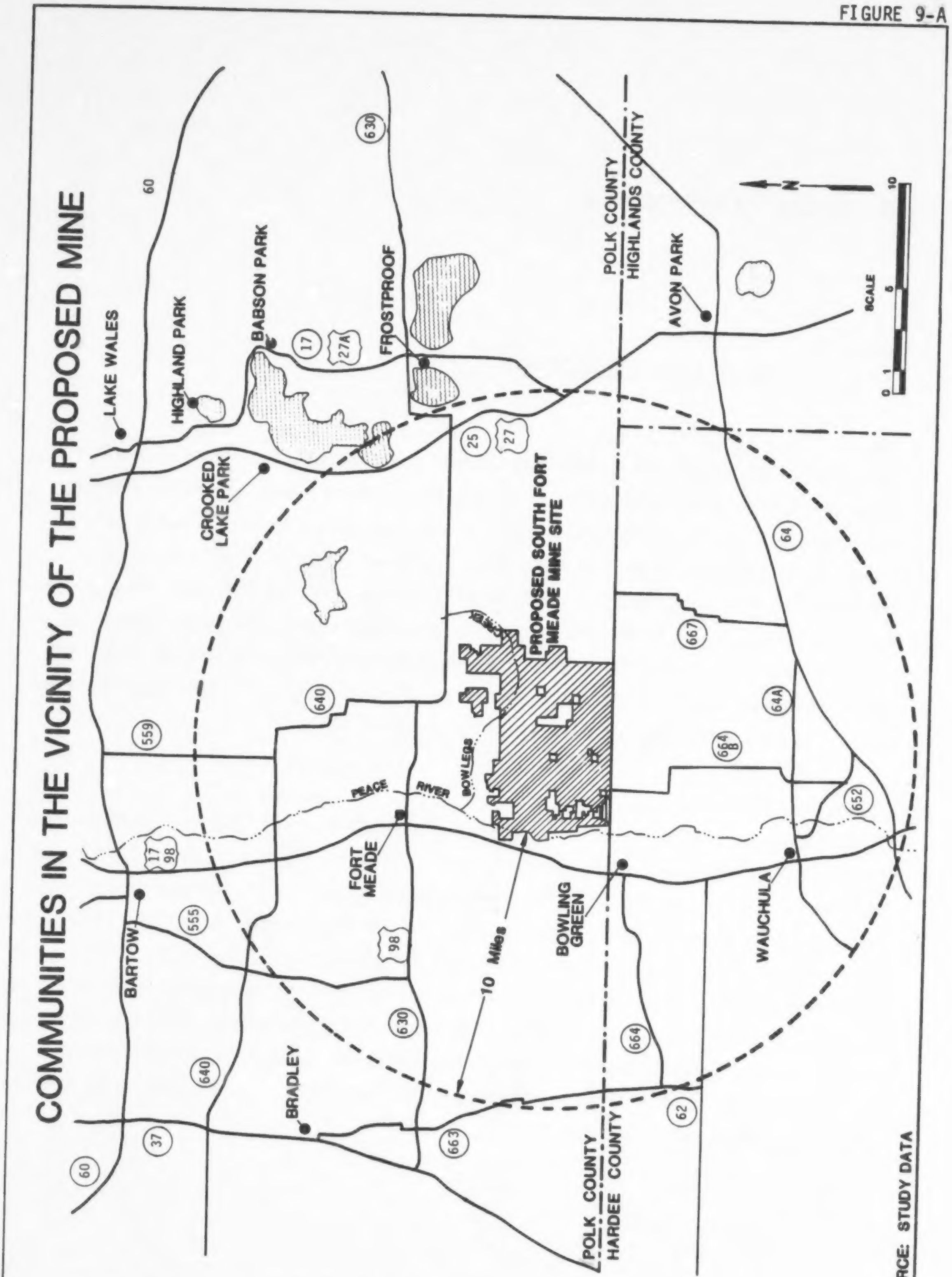
The demographic baseline conditions within the area of the proposed South Fort Meade Mine site are examined in this section. Three counties (Polk, Hardee, and a minor portion of Highlands) are within ten miles of the proposed mine location. Communities within this area are identified on Figure 9-A. A majority of the information presented will concentrate on Polk and Hardee Counties since any action concerning the mine would have the most impact in these areas. An examination of the broader impacts and information about the other counties may be found in the Central Florida Phosphate Industry Areawide Impact Assessment prepared for EPA in September, 1978.

9.1.1.1 Population

Polk County is estimated to have experienced a 25 percent increase between the April, 1970 Census and the University of Florida estimate for July, 1978. The population was projected to have grown from 227,222 to 284,388 persons. Hardee County experienced a slightly smaller increase with the April, 1970 Census population of 14,889 growing to an estimated 17,827 by July, 1978. This represents a 20 percent increase occurring over the eight-year period. The 1978 estimate and a range of projections through the year 2020 are presented in Table 9-1. These projections display between a 48 percent and 96 percent increase for Polk County between 1980 and 2020, and between a 46 and 93 percent increase in Hardee County.

FIGURE 9-A

COMMUNITIES IN THE VICINITY OF THE PROPOSED MINE



SOURCE: STUDY DATA

The 1978 estimates and projections are lower than the numbers previously developed by the University of Florida for the 208 Water Quality Management Plan as shown in Table 9-2. The 208 Study projections developed in 1975 indicate a 1980 population of 318,600 for Polk County and 21,900 for Hardee County. The more recent 1980 projections indicate a high estimate of 301,400 for Polk County and 18,700 for Hardee County.

Table 9-3, also from the 208 Study, indicates the number of temporary residents of the two counties and some of the major communities in the vicinity of the proposed mine site. Temporary residents are either transient or tourist. Those classified as transient visit or reside in the county for longer than 30 days but less than one year and are generally migrant workers and winter residents. Tourists are those people who visit or reside in the county for less than 30 days per year. Polk County has a transient population of 13 percent and a seven percent tourist population. Hardee County has a smaller percentage of temporary residents; one percent of the residents are transients and two percent are tourists. The permanent residents comprise 80 percent in Polk County as compared to 97 percent in Hardee County.

The Areawide Impact Assessment Program indicates that between 1970 and 1975, Polk County experienced a 17.9 percent natural growth and a 82.1 percent migratory growth. Hardee County experienced a 25.2 percent natural growth and a 74.8 percent migratory growth.

The median age of the Polk County population was 29.1 years for the 1960 census and 29.8 years for the 1970 census. People over 65 comprised 12.6 percent of the 1970 census population. Hardee County experienced a decrease in residential age during the decade. The median age of the 1960 Hardee County population was 29.1 years. The median age decreased to 26.6 years with 10 percent of the 1970 census residents being 65 and over.

In Polk County, the number of persons per household is changing significantly. The 1970 census shows 3.05 persons per household compared to 3.29 per household in 1960. It is projected to continue dropping to 2.45 in 1995. The percentage of one person households rose from 11.8 in 1960 to 17.0 in 1970, and is expected to continue increasing through 1995 to 24.3 percent. In Hardee County, the number of persons per household, after a slight increase from 3.33 in 1960 to 3.36 in 1970, is projected to decline slightly to 3.20 by 1995. The percentage of one person households is expected to continue increasing from 13.2 in 1960 to 19.5 in 1995. These figures are displayed in Table 9-4.

9.1.2 LAND USE

The area surrounding the proposed South Fort Meade Mine site is basically rural with large tracts of agricultural land for cattle and citrus production. Mining occurs on several tracts near the proposed mine site. Agriculture and phosphate mining are the backbone of the area's economy. The many freshwater lakes, rivers and wildlife habitats contribute to the aesthetics and quality of life in Polk and Hardee Counties.

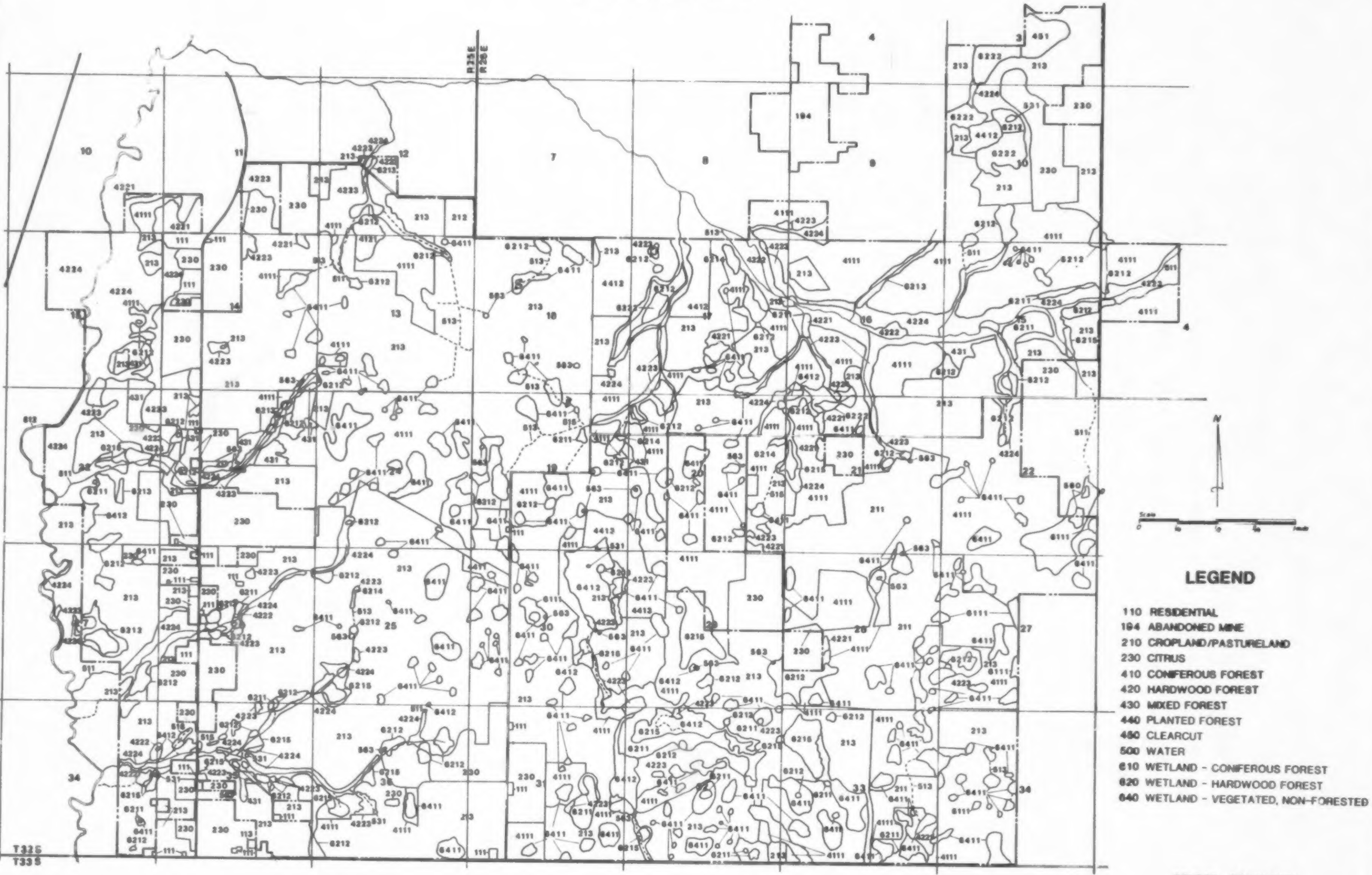
The Areawide 208 Study displays land use figures (Table 9-5) developed by the Central Florida Regional Planning Council. Polk County's major land use is agricultural. Citrus groves, pastures and croplands occupy 42.0 percent of the county land area. A total of 22.0 percent of the county is vacant land. A significant area of Polk County, approximately 224,000 acres, has been mined or is being held by phosphate companies. An estimated 136,200 acres are included in the developed land use category consisting of residential, commercial, industrial (excluding mined lands), recreational and public land.

Approximately 51 percent of the proposed mine site is used for agricultural purposes, as shown on Figure 9-B. Of this, about 47 percent of the site is planted in pasture and crops. A miscellaneous vacant category includes forest, shrubland, grassland, rangeland and wetlands, making up 48 percent of the property. Citrus groves occupy approximately 4 percent of the site. The remaining small portions of the property are covered with water, developed for residential home sites, or vacant for powerline transmission.

FIGURE 9-B

LAND USE AND COVER

BASED ON THE FLORIDA LAND
USE AND COVER CLASSIFICATION



SOURCE: STUDY DATA

The Polk County Comprehensive Plan, prepared in 1979, identifies the following objective and policies concerning mining areas:

> Objective - Mining Areas
>
> To promote continued mining and processing of minerals on lands now in active production or being held for that purpose, as a support to the sound economic base of Polk County.
>
> Policies
>
> 1. Protect, as much as possible, active phosphate mining and processing areas and reserve lands being held for mining from the establishment of incompatible land uses in nearby locations.
> 2. Encourage provision of essential support services and activities necessary to continued mining productivity in Polk County.
> 3. Encourage and promote, through existing regulatory control, the establishment and maintenance of mining and processing procedures that will minimize the emission of pollutants into the air, soil and water resources of Polk County.
> 4. Promote and encourage, through existing regulatory controls, the preplanning of mining operations to facilitate reclamation of lands for beneficial uses.
> 5. Encourage and promote the restoration of previously mined lands for beneficial uses.

In summary, the future land use plan provides for the mining of lands held in reserve and the protection of these lands from adjacent incompatible uses.

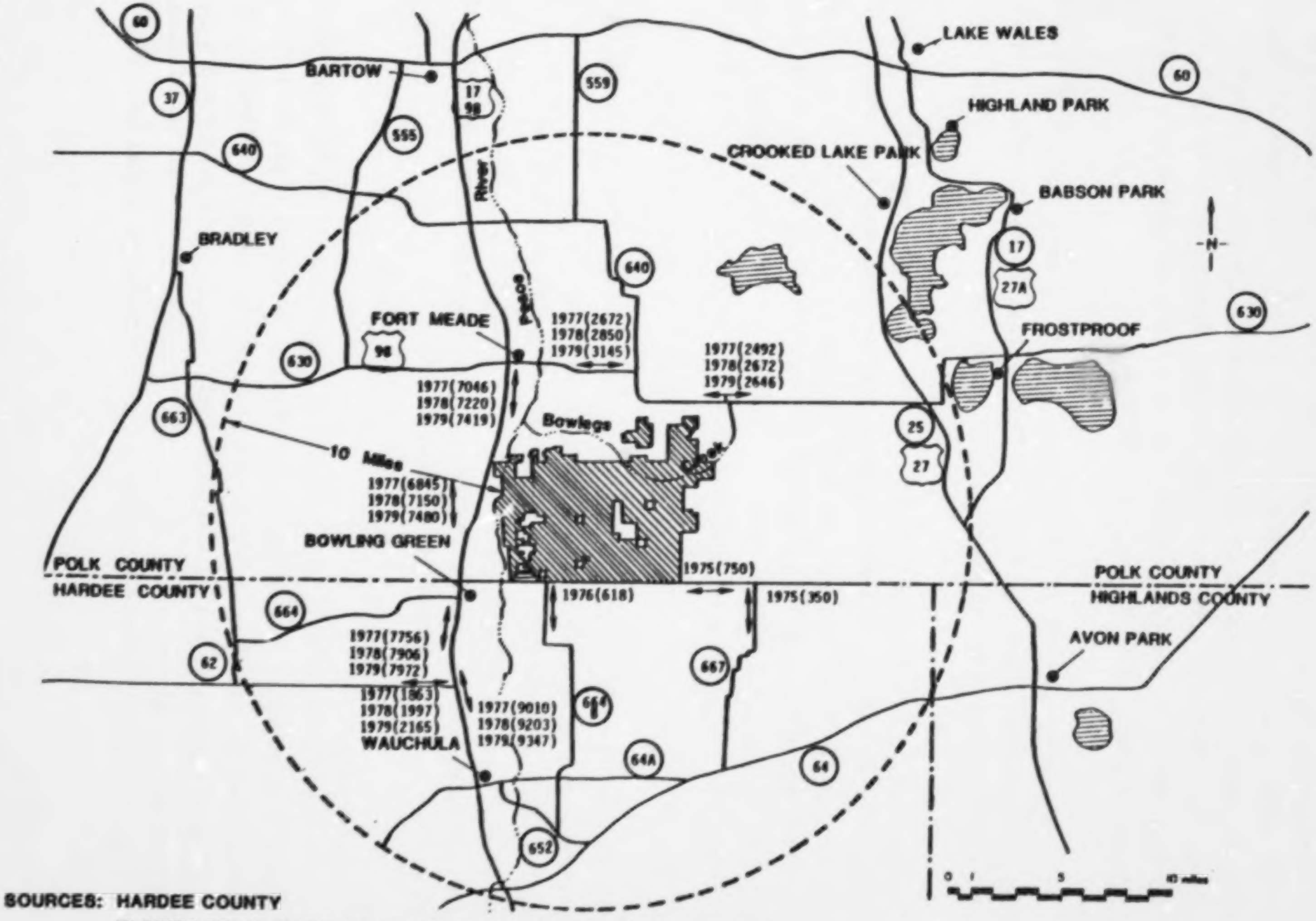
9.1.3 COMMUNITY SERVICES

9.1.3.1 Transportation

Highway vehicles comprise the primary means of passenger and small freight movement. The major hard surfaced road network as well as average daily traffic (ADT) in the vicinity of the South Fort Meade Mine site are shown on Figure 9-C. North of the proposed site, U.S. Route 98 (also identified as State Route 630/700) carries traffic east and west. A 1979 estimate east of the site indicates an ADT of 2,646 vehicles. About seven miles east of the proposed site, U.S. Route 27/98 (State Route 25/700) is utilized by traffic

FIGURE 9-C

TRANSPORTATION FACILITIES AND AVERAGE DAILY TRAFFIC (ADT)



SOURCES: HARDEE COUNTY
FLORIDA DEPARTMENT OF TRANSPORTATION, BUREAU OF PLANNING

between Frostproof and Avon Park. On the south border of the site, also the Polk/Hardee County line, State Route 664 carries traffic east and west. In the vicinity of the southeast corner of the site the ADT was estimated in 1975 at 750 vehicles on State Route 664. West of the site, U.S. Route 17 (State Route 35) provides access between Fort Meade and Bowling Green. Traffic volumes for this route vary from 7,480 ADT near Bowling Green to 7,419 ADT near Fort Meade, as mesured in 1979. Various light and medium duty county roads interconnect these four basic thoroughfares.

The nearest major airport is Tampa International. Scheduled daily flights are provided by several major airlines. Other airports in the vicinity of the site provide service for smaller aircraft.

The Seaboard Coast Line provides rail freight service in the area with tracks adjacent to U.S. Route 17 running through Bowling Green and Fort Meade. Of the approximate 5 million tons produced each year at the Mobil mines, 2.3 million tons are moved by railroad to the Port of Tampa, 1.2 million tons are moved by truck, 0.435 million tons are moved by rail to the interior of Florida, and the balance is transported by rail to chemical plants within the area.

The Port of Tampa provides major dry bulk loading facilities. From this point the cargo can be shipped to other ports in the United States or overseas. During 1978, approximately 24 million tons of the 48 plus million tons of cargo which passed through the Port of Tampa consisted of bulk phosphate and phosphatic chemicals. Of the 24 million tons of phosphate and chemicals, over 15 million tons were slated for foreign export.

9.1.3.2 Education

During the 1978-79 school year, Polk County supported 104 educational facilities consisting of 57 elementary, six middle, 16 junior high, 11 senior high and two special education schools. Three vocational-technical schools and nine adult centers were also located in Polk County. Polk County had a 20.5 to 1 student to teacher ratio in the 1975-76 school year. Southern Florida College, located in Lakeland, presents opportunities for higher edcuation.

Hardee County had four elementary schools, one junior high school and one high school with a full time certified staff of 247 in the 1975-76 school year. The student to teacher ratio for the 1975-76 school year was 19.8 to 1.

9.1.3.3 Water and Sewer Service

Fort Meade is the closest upriver town to the proposed mine site. Its wastewater facilities include one domestic wastewater treatment facility discharging disinfected effluent to the Peace River. It is owned and operated by the city and serves 90 percent of the city's population. The average flow at the plant was 0.45 mgd and the capacity was 0.53 mgd according to the 1978 208 Study. The Fort Meade Water Department provides public water to the city residents and local industries at an average daily consumption rate of 1.0 mgd from one of three wells. The source of this water supply is groundwater withdrawal. One of the industries utilizing the municipal water supply and treating its own waste is involved in fruit packing. This industry sprays/irrigates its effluent.

The City of Bowling Green lies across the Peace River southwest of the proposed mine site. The municipal treatment plant was treating 0.16 mgd with a capacity of 0.20 mgd during 1976. This plant discharges disinfected effluent to the Peace River. The Bowling Green Water Department provides an average of 0.20 mgd to the city's residents through groundwater withdrawals.

There are no public water or sewage facilities at the proposed mine site. The 208 Study indicates that service growth over the next 20 years will be confined within the municipal boundaries of Fort Meade and Bowling Green.

9.1.3.4 Energy Utilities

Electrical energy is supplied to this area by a network of high-voltage transmission lines interconnecting the load areas of more than 35 power plants owned by various companies. A 35 MW (megawatt), oil-fired power plant located in Avon Park is owned by the Florida Power Corporation (FPC). Interconnected power facilities are located at Wauchula, Bartow and Sebring. The FPC has two transmission lines running through the site. A 69 kV (kilovolt) line runs diagonally through the center of the site from the northwest to the southeast and is slated for upgrading to 230 kV. The other line traverses the northeast corner of the proposed mine site and is currently rated at 115 kV. Both lines run between Avon Park and Fort Meade.

9.1.3.5 Public Protection

Public protection and health statistics derived from the Areawide EIS are displayed in Table 9-6. The number of policemen, firefighters, doctors and hospital beds are shown by county in relation to the 1976 population. The local communities support and maintain police and fire protection. Hospitals are located in Avon Park, Bartow, Sebring and Wauchula.

9.1.3.6 Recreational Opportunities

Public recreational areas are administered on a Federal, state, county and municipal basis. These facilities include parks, campgrounds, ballfields, gold courses and others. Some private facilities augment the public sites. The Areawide EIS indicates the existence of 71,210 acres in Polk County and 771 acres in Hardee County for recreational use. No public or privately owned recreation land is located adjacent to the proposed mine site.

9.1.3.7 Housing

Housing statistics, presented in Table 9-7, can be viewed as an indicator of economic activity. As the population expands and growth occurs there is an increased need for housing units, prompting the construction market to build. Housing standards, based on valuations and plumbing facilities, serve as an indicator of social well-being.

Information compiled for the Areawide EIS indicates that Polk County experienced a 26 percent increase in housing units between 1960 and 1970, and an additional 28 percent increase between 1970 and 1976. The average value of a house in 1970 was $11,800. Hardee County experienced an 18 percent increase in units during the 1960's; this rate approximates the increase in population. In 1970, the average value of a house in Hardee County was $8,600. Between 1970 and 1976, there was a 29.4 percent increase in housing units.

Polk and Hardee Counties experienced similar occupancy rate growth from 1960 to 1976. In 1960, both counties had approximately 90 percent occupancy with

1970 figures showing 91 percent. In 1976, Polk and Hardee Counties experienced 95 percent occupancy.

9.1.4 ECONOMICS

9.1.4.1 Employment

The economic base of a region or county is composed of two major segments: the resident labor force and the activities, such as manufacturing and commerce, that provide employment and/or produce a product. Between 1968 and 1978, Polk County experienced an estimated increase of 39 percent in the labor force, increasing from 89,600 in 1969 to 124,654 in 1978. Unemployment rose from 4.1 percent in 1969 to a peak of 7.2 percent in 1972, dropped to 4.5, then rose to another peak of 8.4 percent in 1977. These estimates from the Florida Department of Commerce are shown in Table 9-8. Employment by industry for 1976 is presented in Table 9-9. Because the mining industry is a nondisclosure industry, representative figures are not reported. According to the 208 Study, information obtained from the Lakeland Chamber of Commerce identified 10 major phosphate companies operating in Polk County during 1975-76. The total estimated employees for all the companies included 6,152 workers, many of whom are involved in the manufacture of phosphate-related products as well as mining.

The labor force in Hardee County rose from a low of 4,300 people in 1967 to a high of 8,438 people in 1970. The decade from 1968 to 1978 displayed an increase of 78 percent in the Hardee County labor force. The estimates for the period from 1967 to 1978 are shown in Table 9-8. Unemployment rose from 1.9 percent in 1967 to 6.1 percent in 1978.

9.1.4.2 Income

During the 10 year period of 1966 to 1976, the average per capita personal income levels from lowest to highest order were Hardee County, Polk County, State of Florida and the United States. The income levels are presented in Table 9-10 as estimated in U.S. Department of Commerce unpublished data.

An examination of the 1977 average wage and salary income by industrial division (Table 9-11) reveals that employees of the mining industry have the highest average wages. Polk County mining workers received approximately 46 percent more than the average state-wide industrial wage of $10,032. Unclassified Industries and Trade workers earned the lowest average wages. A 1974 Bureau of Mines study indicates that each new job in the phosphate industry generates 6.155 other jobs in the area. For each dollar of income earned in the phosphate industry, $3.363 of other income is generated.

9.1.4.3 Taxes

There are several taxes and taxing authorities in Polk County. Polk County levies an ad valorem tax on the value of phosphate producing land ($3,000 per acre) and a property tax on the value of buildings, equipment and other land holdings. The millage of these taxes is as follows:

1.	County rate	4.0
2.	School District	7.136
3.	Peace River Basin Water District	.190
4.	Southwest Florida Water Management District	.100
	Total	11.426

The state levies a 10 percent severance tax on the value of a product at the point of severance. Other taxes which the state levies are a 4 percent sales tax on materials and supplies, a 5 percent corporate income tax on net income and a motor fuel tax. The Federal government levies an income tax on employee income and on corporation income.

9.1.5 CULTURAL RESOURCES

9.1.5.1 Introduction

Data obtained from articles, maps and monographs were used to determine the physical and social development of Polk County in general, and Bowling Green, Fort Meade and Wauchula specifically. In addition, archaeological survey and site reports, the Fort Meade site file, recent EIS statements, information from private collectors and local residents, and theoretical and substantive geological, ecological and anthropological material were considered. This literature is available from the James A. Ford Library, the Florida State Museum; P.K. Yonge Library, the University of Florida; and the Polk County Historical and Genealogical Library, Bartow, Florida. Terminology used in this discussion may be generalized or incorrect from a geological or ecological technical viewpoint. The geological section and biological section of this document reflects the accurate information for these areas.

The site inspection consisted of a walk-through survey and intensive subsurface sampling. Observations varied within the survey area due to density of ground cover, or shrub and/or leaf litter vegetation. The tract consists primarily of open pasture with some areas containing very dense secondary growth, while others are mesic hammocks. In all cases, surface conditions did not seriously hamper identification of remnant structures or refuse deposits of possible historic significance.

9.1.5.2 Archaeological Survey

9.1.5.2.1 Environment

The proposed mine site lies within the flatwoods physiographic region which, in central and southern Florida, extends from Pasco to northern Collier County (Davis, 1967). The northern and western portions of the site contain secondary and primary tributaries of the Peace River. Other aquatic environments within the area consist of low lying swamps, bayheads and mesic and xeric hammocks. The interior of the site is predominately poorly drained flatlands containing cypress swamps and sinkhole ponds. Small isolated mesic hammocks occur in association with discontinuous sand ridges near the waterways and other water sources.

The area has undergone extensive alterations as a result of human activities with the most recent changes a result of clearing for pasture and farming. Numerous small canals have been dug around bayheads for drainage near crops, while ponds have been created for cattle in some areas. Approximately 60 percent of the site is now pasture. Artificial mounds dot the landscape, a result of leveling and piling underbrush.

Before the mid-twentieth century, land surface disturbances were related to cash-crop agriculture, truck farms, logging, and phosphate mining as well as natural disturbances. One resident noted, for example, severe vegetation disturbances related to hurricanes in 1926 and again in 1937. Surface disturbances resulting from nineteenth century cash-crop truck farming and nineteenth and twentieth century penetration for timber, commercial agriculture and mining interests are characteristic for the entire tract. The land surface is generally non-depositional in nature with slow natural soil accumulation. Within these environments, prehistoric sites tend to be shallow, within 50 cm of ground surface.

9.1.5.2.2 Cultural Resources

Prehistoric: During the course of this study, two aboriginal ceramic period sites were encountered, as were numerous isolated chert flakes (impure flint chips or small tools) and one isolated unifacial scraper (one-sided flint scraper). These isolated finds are probably the result of single cultural events representing hunting activities at the locus of discovery. Given the disturbances of these sites, it is doubtful that they are contained within their environments of deposition, and no judgment can be made as to cultural association. No other archaeological studies need to be undertaken.

Two other sites were encountered from post-Archaic periods and were probably task-specific. Both were in disturbed context on the south bank of the northernmost tributary of the Peace River (within the survey area), and probably within what was at one time mesic hammock. One site contained two non-utilized chert flakes and six sand-tempered, plain sherds (pottery pieces). All sherds came from a single test pit. Given the disturbances at this site, it is impossible to determine whether the flakes and sherds represent a single event or events from a temporal sequence. The other site, located in what is now an orange grove, contained two very chalky sherds, nine non-utilized flakes and one Pinellas point. No other action is recommended for these two sites.

In summary, the survey area appears to be one of minimal aboriginal activity. While isolated sites occur, they are thought to result from single cultural events representing hunting activities at the locus of discovery.

Historic: The interior portion of Florida was relatively impenetrable until access was made available by a military road created in 1836 across the peninsula from Fort Hower on the Manatee River to Fort Capron on the Indian River. This road crossed the Peace River at Chiconicla Ford, four miles north of the present town of Wauchula (Fryman, 1976).

The Seminoles came to southern Polk County before the Second Seminole War (1835-42). After the war, they were moved to areas south and east of the Peace River.

Official land surveys began in 1843 when Henry Washington ran the meridian between ranges 22 and 23. No townships were sectioned until after 1855. During this early period, settlement consisted of primitive forts and trading posts. One of the earliest forts in the immediate area was the fort set on a high bluff overlooking Chiconicla Ford, four miles east of present-day Wauchula and one mile south of Bowling Green. Dempsy Whiddon established a trading post nearby which was attacked by Indians and was abandoned in 1850. Fort Hartsuff (1851) was built two miles southwest of Wauchula, and Fort Green (1856) at some point west of the present Wauchula city limits (Fryman, 1976).

Settlement of the area began around 1850 with fewer than a dozen families. Expanded settlement in Wauchula occurred in the 1880's, but Bowling Green was still unknown as a town in 1885. Bowling Green and Wauchula grew as a result of construction of the Florida Southern Railroad from Bartow to Punta Gorda after 1886. Bowling Green and Wauchula were then known as Utica and English Post Offices, respectively. Following the establishment of the railroad there was an influx of European settlers (Witt, 1976 and Fryman, 1976).

Historic sites encountered during this study were a part of very late nineteenth and early to mid-twentieth century developments. The economic base was chiefly agriculture (citrus fruit and winter vegetables), livestock and support industries such as canning and crate manufacturing. There were also logging and timber industries.

Of the 15 historic sites located within the tract, 12 were twentieth century homesteads and outbuildings. Two were remnants of a twentieth century turpentine still, one "company house" for black workers employed at the still and parts of a tramway built for use by the timber industries. The sites are listed and discussed as follows:

Site	Description
HS 1	Brick scatter, remnant well (20th century house site).
HS-2	Mid-twentieth century refuse.
HS-3	Twentieth century refuse, "staging area" for orange grove.
HS-4	Pre-1941 house site, well and pitcher pump.
HS-5	Post-1941 storage shed.
HS-6	Second Kedney homestead--foundation, chimney falls, furnace, sturctural poles for pole barn (20th century).
HS-7	First Kedney homestead--chimney, furnace, two wells, structural poles for pole barn (20th century).
HS-8	House site, refuse, pre-1941.
HS-9	20th century, scattered refuse.
HS-10	Post-1941 mill lumber, animal pen.
HS-11	Well and brick scatter, ca. 1941.
HS-12	Brick scatter only. House, ca. 1941.
HS-13	Workers' houses associated with turpentine still, resin slag, turpentine cups, ca. 1920.
HS-14	Brick, scatter from turpentine still, resin slag, turpentine cups, ca. 1920.
HS-15	Tramway bed segments, sand no tracks.

The tramway does not appear on any of the historic railway maps of the area (Treveres 1883, Unknown 1883, Colton 1884, Rand McNally 1890), and probably represents a spur line for logging or perhaps phosphate interests. There are no rails or ties visible on the remaining few segments. A 70x80x90 cm trench placed across the existing bed at this section was constructed over a swampy, unmodified surface. Fill for the elevated bed came from both sides of the line; ditches are still evident in this section. The width of the tramway bed was seven meters east to west. No other archaeological investigation is recommended for this site.

Historic Site 13 contained disturbed refuse deposits associated with workers' houses for turpentine-manufacturing employees. There are no standing structures and intensive tests revealed no associated features. Brick remnants of the turpentine still are visible at Site #14, as were tin and ceramic turpentine cups, coopers' tools, metal bands for barrels and resin slag deposits. Local residents report the still to have been briefly operative around 1920. A title search of the property revealed the land belonged to South Carolina Mining and Manufacturing Company (1920) and was transferred to Virginia-Carolina Chemical Company in 1942. It is not known whether this company operated the still or leased the land for manufacturing purposes. No other archaeological action is recommended for this site.

It was determined from archival and field investigations that no prehistoric or historic resources of National Register quality are on the proposed South Fort Meade Mine site; therefore, no further archaeological study is recommended.

9.1.5.3 Quality Assurance

The archaeological and historic investigation was performed by personnel from the Department of Social Services, Florida State Museum, University of Florida. These personnel are recognized experts in the fields of archaeology and historic resources.

9.2 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

9.2.1 THE NO ACTION ALTERNATIVE

Mobil's existing Fort Meade Mine will cease production during the latter half of this decade. If Mobil does not develop the South Fort Meade site as a replacement mine, the contribution to the economy of the area through employment, tax payments, and other economic factors will decline and eventually cease with the completion of mining at the Fort Meade facility. The current 175 permanent employees and the $3.7 million payroll (1980 dollars) at the Fort Meade Mine would be phased out. The $5.5 million in taxes (1980 dollars) from the Fort Meade Mine would also be lost.

The primary economic effect of the no action alternative would be felt by the Mobil employees dependent for their jobs and income on the phosphate mining industry. The loss of secondary income from indirect employment and material and service suppliers would amount to approximately $50 million (1980 dollars) per year. Land use would likely remain in its present agricultural state, although some wetland areas and other miscellaneous land categories on the site might eventually be developed for pasture or other agricultural land uses. Property values without the developed mine would decrease relative to the value for phosphate mining. The no action alternative would reduce traffic levels on local roads and the Seaboard Coastline Railroad. Demands for services such as housing, schools, fire protection, police and medical services would decrease.

9.2.2 THE ACTION ALTERNATIVES INCLUDING THE PROPOSED ACTION

Impacts on the human resources in the area of the proposed mine site have not been evaluated in the same subsystem format as the other resources previously presented. The human resources evaluation presents the no action alternative versus Mobil's proposed action except in the discussion of land use where alternative reclamation plans are discussed and product transport where alternative modes of transportation are discussed.

9.2.2.1 Demographics and Economics

During the two construction periods at the South Fort Meade site, construction labor would average 400 employees with a peak labor force of 600 employees. Approximately 95 percent of the construction labor would come from the existing central Florida labor pool, providing ongoing employment for construction industry personnel in the area. Permanent operating employment is expected to stabilize at 233 employees, most of whom would be transferred from Mobil's existing facilities while the rest would be hired from the local labor pool. Total regional secondary employment generated by operation of the facility is projected to be between 900 and 1,430. Total secondary income from indirect employment is estimated at $350 million.

Construction labor expenditures for the two phases of development would total $240 million (1980 dollars), with the total labor payroll at $70 million. The annual operations payroll for the mine would be approximately $5.1 million (1980 dollars) per year. Most of the construction labor expenditures, and essentially all of the operations expenditures, would accrue to the region.

Mobil's proposed South Fort Meade Mine would generate revenue for Polk County through ad valorem taxation and redistribution of sales tax collected in Polk County. Once operations commence, the annual revenue generated (in 1980 dollars) by the proposed mine is estimated at $2.2 million in property tax and $300,000 in sales tax. Approximately 35 percent of the ad valorem revenue would go to the general county fund, 62 percent to the school district, and 3 percent to the SWFWMD and the Peace River Basin Water District. The mining operation would also generate about $5.6 million in severance tax revenue annually, of which 50 to 75 percent would go to the General Revenue Fund of the State of Florida. The remainder of the revenue would be credited to the Land Reclamation Trust Fund and the Florida Institute of Phosphate Research.

9.2.2.2 Cultural Resources

Pursuant to Section 106 of the National Preservation Act, EPA consulted with State Historic Preservation Officer (SHPO) and the Florida Division of Archives, History and Records Management, to obtain an evaluation of the cultural resource impacts of the Mobil project. Based on the inventory conducted by Florida State Museum authorities, archival and field evidence indicates the absence of prehistoric or historic resources of National Register quality within the proposed mine site's boundaries. The site is not close to any known historic or archaeologic site. The SHPO provided EPA his opinion that the proposed South Fort Meade mine would not affect any archaeological or historic sites listed, or eligible for listing, on the National Register of Historic Places, or otherwise of national, state or local significance (Percy, 1980).

9.2.2.3 Community Services

The proposed South Fort Meade facility will essentially be a replacement mine for a currently active Mobil mine in Polk County. The labor force for the new facility would generally be drawn from that of the phased-out existing facility and would not result in an influx of people that would impose additional demands on the present community service facilities. Therefore, the proposed facility is considered not to have an impact on community services.

9.2.2.4 Land Use

The principal socio-economic issue associated with waste disposal and reclamation is the ultimate use of the land after mining. Table 9-12 presents a summary of the land use units that the reclaimed mine site would contain as a result of each waste disposal/reclamation plan (the proposed action and three alternatives). Due to the rural setting of the mine site, the ultimate utility of the site for urban purposes is not as important to the economy of the area as the use of the land for agriculture.

Conventional Clay Settling Plan (Mobil's Proposed Action): During the life of the mine, 15,194 acres of the 16,288-acre site would be disturbed. The undisturbed areas of the site are wetlands and flatwoods, considered to be economically unproductive in their current use. All of the land area on the site that is currently economically productive (cropland, improved pasture, citrus groves and planted pines), about 54 percent of the total site, would be disturbed as a result of mine implementation.

With the completion of the conventional reclamation plan, agricultural landwould increase 39 percent, from 8,282 acres to 11,521 acres. Most of the flatwoods (3,452 acres) on the site are presently unmanaged pasture areas and with the conversion of these areas to managed agricultural units, the economic productivity of the whole mine site would increase over current levels. The 566 acres of citrus groves on the site (0.3 percent of the citrus producing land in Polk County) would be lost. Planted pine areas would increase from 339 acres to 453 acres upon completion of reclamation, while other forested areas would remain essentially unchanged. Freshwater swamps and marsh areas would also remain with approximately the same acreage.

Sand/Clay Cap Plan: The sand/clay cap reclamation plan would designate 11,111 acres as agricultural land, representing a 34 percent increase over that existing. Because the 7,580 acres of 4:1 sand/clay cap material would be more tillable than the 6,681 acres of clay in the conventional plan, the sand/clay cap plan has a better potential for economic productivity through agricultural use than the reclaimed land in the conventional plan. Planted pine acreage would increase from the existing 339 acres to 536 acres with the other forested areas increasing only slightly in size. Freshwater swamps and marsh areas would remain essentially unchanged.

Sand/Clay Mix Plan: This reclamation plan would result in 10,421 acres devoted to agricultural use, representing a 26 percent increase over the existing amount. The 3,512 acres of 2:1 sand/clay mix material would be tillable which would allow for greater agricultural productivity than with the conventional reclamation plan. Planted pine acreage would increase to 431 acres with the sand/clay mix plan. More acreage (2,120 acres) would be planted as forest than with the conventional plan (1,930 acres). Freshwater swamp and marsh acreage would remain essentially as it is.

Overburden/Clay Mix Plan: In this plan, 10,421 acres would be designated for agricultural use. The 7,670 acres of 2:1 sand/clay mix would be tillable and more productive than the 6,168 acres of clay associated with the conventional plan. Other land use acreages would be similar to those for the sand/clay mix plan.

9.2.2.5 Transportation

Highway and road traffic would be increased as a result of construction and operation of the South Fort Meade Mine. It is anticipated that most mine-related traffic would use Mt. Pisgah Road from Fort Meade to County Line Road to Manley Road to the plant site. County Line Road has an average daily traffic count (ADT) of 750. The traffic load on County Line Road is considered typical of traffic on paved routes in the project area and is, therefore, used as the basis for comparing premine traffic to the traffic during mining construction and operation. The following two assumptions have been made in estimating traffic volumes related to mine construction and operation: (1) 15 percent of the existing ADT occurs between 10:00 PM and 7:00 AM, the remainder being distributed evenly throughout the daytime hours; and (2) a car-pooling factor of 1.7 persons per vehicle is applied to the labor force. Using these assumptions, the following peak traffic volumes and ADT's are estimated for Mt. Pisgah Road and County Line Road during Phase I and II construction and operation periods.

Period	Peak Traffic Volume (vehicles per hour)	ADT
Existing (based on 1975)	38	750
Phase I Construction (maximum period, 1983)	391	1,456
Phase I Operation (1984)	74	923
Phase II Construction (1985)	427	1,629
Phase II Operation (1986-2006)	94	1,025

The flow of mine-related traffic would be opposite to the travel of those residents who live near the mine and work in adjacent communities.

The peak traffic volume of 427 vehicles per hour would occur in 1985 when Phase I operation and Phase II construction activities overlap. The maximum service volumes for a two lane paved road similar to Mt. Pisgah Road and County Line Road is estimated as 900 vehicles per hour. Therefore, the peak project induced traffic on the local roads is still less than half the maximum service volume. The peak traffic volume would occur during 1985 and would drop off for the remainder of the mine life. Construction related equipment would also be transported on the local roadway system from 1982 through 1986, possibly creating some local short-term traffic congestion problems.

Transportation of the product is the second major transportation demand that could present a socioeconomic impact. The proposed action (railroad) and alternative method (truck transport) are discussed below.

Railroad (Proposed Action): The proposed construction of a rail spur from the existing Seaboard Coastline tract west of the mine to the beneficiation plant would be along a 100-foot wide approximately 6-mile long corridor acquired by Mobil. There would be one grade crossing on Mt. Pisgah Road which would be crossed four times each day. During Phase I operations, the trains would consist of one locomotive and 33 cars. During Phase II operations, the same number of train trips would be required but each train would have 65 cars. Each train crossing would block traffic on Mt. Pisgah Road for approximately six minutes. The right-of-way for the spur would traverse woodland areas and improved pasture.

Truck: During Phase I operations, 45 trucks would have to make 260 round trips per day in order to move the product from the mine to Nichols. Twice as many round trips would be required to implement Phase II operations. During Phase I operations, more than 100 additional personnel would be required to drive the trucks and service them. During Phase II operations, the personnel requirement would double. The movement of these trucks would increase the maintenance requirements for area roadways due to the increased vehicle weight and traffic volumes.

9.3 REFERENCES

Abbitt, Ben and Muraro, 1979. Budgeting Costs and Returns: Central Florida Citrus Production, 1978-79, University of Florida Food and Resource Economics Department, Gainesville, Economic Information Report 113.

Allen, R., 1948. The Big Circle Mount, The Florida Anthropologist 1:17-21.

Anderson, C.L. and Hipp J.S., 1974. Requirements and Returns for 1000-Cow Beef Herds on Flatwood soils in Florida, University of Florida Cooperative Extension Service, Gainesville, Circular 385.

Batcho, D., 1978. Archaeological and Historical Resources within the Little Payne Mining Tract, Polk and Hardee Counties, Florida, Miscellaneous Project Report Series Number 11, Florida State Museum, Gainesville, Florida.

The BDM Corporation, 1977. Review of Non Technical Areas of the Draft Generic Environmental Impact Statement on Commercial Radioactive Waste, McLean, Virginia.

Booz, Allen and Hamilton, 1979. Economic Impact Assessment of the Port of Tampa.

Brooke, D.L., 1974. Citrus Production Costs and Returns in Florida, Season 1972-1973 with Comparisons, IFAS Economic Report 67, Gainesville: University of Florida.

Carr, R.S., 1975. An Archaeological and Historical Survey of Lake Okeechobee. Florida Division of Archives, History and Records Management, Bureau of Historic Sites and Properties, Miscellaneous Project Report Series, No. 22. Tallahassee, Florida.

Central Florida Regional Planning Council, 1978. Growth and Land Development Policies, Bartow, Florida.

Central Florida Regional Planning Council, 1978. Housing Market and Needs Analysis, Bartow, Florida.

Central Florida Regional Planning Council, 1978. Central Florida Areawide Water Quality Management Plan, Bartow, Florida.

Chalmers, J.A. and Anderson, E.J., 1977. Economic/Demographic Assessment Manual: Current Practices, Procedural Recommendations and a Test Case, prepared for the Bureau of Reclamation by Mountain West Research, Inc., Tempe, Arizona.

Cockrell, W., 1970. Glades I and Pre-Glades Settlement and Subsistence Patterns on Marco Island, Collier County, Florida, unpublished M.A. thesis, Department of anthropology, Florida State University.

Colton, G.W. and C.B. Colton, 1884. Map of Florida.

Colton, G.W. and C.B. Colton, 1884. Maps showing the Florida Railway System.

Cram, 1895. Railroad and County Map of Florida.

Davis, J.H., 1967. General map of Natural Vegetation of Florida, Agricultural Experiment Station, University of Florida.

Florida Crop and Livestock Reporting Service, 1978. Florida Agricultural Statistics: Commercial Citrus Inventory as of January 1978, Orlando.

Florida Crop and Livestock Reporting Service, 1978. Florida Agricultural Statistics: Livestock Summary 1978, Orlando, Florida.

Florida Department of Banking and Finance, 1979. Local Government Financial Report, Fiscal Year 1977-78.

Florida Crop and Livestock Reporting Service, 1978. Florida Agricultural Statistics: Citrus Summary 1978, Orlando, Florida.

Florida Department of Commerce, Bureau of Economic Analysis, 1979. Hardee County Economic Analysis, Tallahassee, Florida.

Florida Department of Commerce, Bureau of Economic Analysis. Highlands County Economic Analysis, Tallahassee, Florida.

Florida Department of Commerce, Bureau of Economic Analysis, 1978. Polk County Economic Analysis, Tallahassee, Florida.

Florida Department of Administration, Division of State Planning, 1976. The Florida Land Use and Cover Classification System: A Technical Report, Tallahassee, Florida, (DSP-BCP-17-76).

Florida Department of Administration, Division of State Planning, 1976. Regional Impact: Guidebook for Preparation of the Application for Development Approval, Tallahassee, Florida. (DSP-BLWM-34-76).

Florida Department of Revenue, 1980, Tax Research Office, personal conversation.

Florida League of Cities, 1979. Officials of Florida Municipalities, 1979, Tallahassee.

Florida Phosphate Council, 1979. Economic Fact Sheet, Lakeland, Florida.

Florida Phosphate Council, 1979. Environmental Fact Sheet, Lakeland, Florida.

Fradkin, A., 1976. The Wightman Site: A Study of Prehistoric Culture and Environment on Sanibel Island, Lee County, Florida, unpublished M.S. thesis, Department of Anthropology, University of Florida.

Fryman, M., 1976. "Colonial Inhabitants of Hardee Area were Few in Number." Modified by editor, The Herald-Advocate, July 1, 1976.

Goggin, J., Cultural Occupation at Goodland Point, Florida. 1949a. Florida Anthropologist 2:65-91.

1949b. Cultural Traditions in Florida Prehistory, In: The Florida Indian and His Neighbor, edited by John W. Griffin, pp. 13-44, Rollins College Inter-American Center, Winter Park.

1950a. Stratigraphic Tests in the Everglades National Park; 1951 Florida Anthropologist 4:50-60, Archaeological Notes on Lower Fisheating Creek.

Highway Research Board, National Academy of Sciences, 1965. National Research Council, Highway Capacity Manual, Special Report 87, Washington, D.C.

Miernyk, William H., 1967. The Elements of Input-Output Analysis, Random House, New York.

Milanich, J.T. and C. Dowling, 1975. An Archaeological Survey in Northwestern DeSoto County, Florida. Manuscript on file, Florida State Museum.

Milanich, J.T., R. Marrinan, and C. Martinez, 1975. Archaeological and Historical Resources of the Carlton Ranch, Limestone, and Olliff Properties, Hardee County, Florida. Manuscript on file, Florida State Museum.

Milanich, J.T. and R. Willis, 1976. Archaeological and Historical Resources of the Fort Green Mine, Hardee County, Florida, Manuscript on file, Florida State Museum.

Milanich, J.T. and R. Willis, 1977. Archaeological and Historical Resources of the Farmland Industries, Inc. Property, Hardee County, Florida. Miscellaneous Project Report Series, Florida State Museum, Gainesville.

Mountain West Research Incorporated, 1975. Construction Worker Profile, A Study for the Old West Regional Commission, Washington, D.C.

Peacock et al., 1976. Forage Systems, Beef Production, and Economic Evaluations, South Central Florida, Florida Agricultural Experimental Station Bulletin 783.

Percy, G.W., 1980. Letter from George W. Percy, Deputy State Historic Preservation Officer, to A. Jean Tolman, U.S. EPA Region IV, December, 1980.

Polk County Planning Agency, 1979. Fort Meade Comprehensive Plan.

Polk County, 1979. Polk County Comprehensive Plan.

Pritchett, W. L. and J. W. Gooding, 1975. Fertilizer Recommendations for Pines in the Southeastern Coastal Plain of the United States, Florida Agricultural Experimental Station Bulletin 774.

Rand McNally Co., 1890. Railroad map, South Carolina, Georgia, Florida, and Alabama.

Real Estate Corporation, 1974. The Costs of Sprawl, U.S. Government Printing Office, Washington, D.C.

Richards, S., 1978. Geographic Technique for Differentiating Archaeological Sites in Florida. Unpublished M.A. thesis, Department of Geography, University of Florida.

Richardson, Harry W., 1972. Input-Output and Regional Economics, John Wiley & Sons, New York.

Robertson, A., 1973. Hydrologic Conditions in the Lakeland Ridge Area of Polk' County, Florida, Bureau of Geology, Florida Department of Natural Resources, Tallahassee.

Sears, W., 1971 . Food Production and Village Life in Prehistoric Southeastern United States, *Archaeology* 24:93-102.

Sears W., 1974. Archaeological Perspectives on Prehistoric Environment in the Okeechobee Basin Savannah. In: *Environments in South Florida: Presentand Past*, edited by P.J. Gleason.

Sears, E. and W. Sears, 1976. Preliminary Report on Prehistoric Corn Pollen from Fort Center, Florida. Southeastern Archaeological Conference *Bulletin* 19:53-56.

Shelford, V., 1963. *The Ecology of North America.* University of Illinois Press, Urbana.

Smith, H., 1956. The European and the Indian. *Florida Anthropological Society Publication* No. 4.

Steinen, K., 1971. Analyses of the Non-Ceramic Artifacts from a Hopewellian Affiliated Site in Glades County, Florida. Unpublished M.A. thesis, Department of Anthropology, Florida Atlantic University.

Swift Agricultural Chemicals Corporation, 1978. Development of Regional Impact, Duette Mine Manatte County, Florida.

Tampa Port Authority. Port of Tampa, Florida.

Texas Instruments, Incorporated, 1977. Environmental Land Use Planning: An Integrated Theme for Areawide Impact Assessment of the Central Florida Phosphate Industry, Proceedings of a Seminar in Bartow, Florida, co-sponsored by the United States Environmental Protection Agency and Texas Instruments, Incorporated, Larry Bowles, Beverly Littlejohn, and Ruth Wilson (eds).

Treveres, J.J., 1883. Map of Polk County, Florida. Photostat.

U.S. Bureau of Mines. Economic Analysis Branch Information Circular, Economic Significance of the Florida Phosphate Industry: An Input-Output Analysis, forthcoming.

U.S. Bureau of the Census, 1978. Governmental Finances in 1976-77, U.S. Government Printing Office, Washington, D.C. (GF 77 No. 5).

U.S. Bureau of the Census. 1979 Census of Population: General Population Characteristics, Florida, U.S. Government Printing Office, Washington, D.C., (PC(1)-B(11).

U.S. Bureau of the Census, 1970 Census of Population: Detailed Characteristics, U.S. Government Printing Office, Washington, D.C. PC(1)-D(11).

U.S. Bureau of Mines, 1974. Economic Analysis Branch Information Circular 8653: Economic Significance of the Florida Phosphate Industry.

U.S. Department of Commerce, Bureau of Economic Analysis, 1977. Inter-Specific Gross Output Multipliers for BEA Economic Area, U.S. Government Printing Office, Washington, D.C.

U.S. Department of Commerce, Bureau of Economic Analysis and U.S. Department of Agriculture, 1974. Economic Research Service, 1972 OBERS Projections,Regional Economic Activity in the U.S. Series E Population.

U.S. Environmental Protection Agency, 1978. Final Areawide Environmental Impact Statement, Central Florida Phosphate Industry (EPA 904/9-026a).

University of Florida Bureau of Economic and Business Records, 1978. Population Studies: Bulletin Number 48, Gainesville, Florida.

Unknown, 1883. Map of the Jacksonville, Tampa and Key West Railway. From Yullee Collection.

Uuacek, Edward and Hauenga, Wayne, 1978. How much debt can a beef cow carry? Simmental Shield.

Van Beck, J. and L. Van Beck, 1965. The Marco Midden, Marco Island, Florida. Florida Anthropologist 18:1-10.

Willey, G., 1949. Excavations in Southeast Florida. Yale University Publications in Anthropology 42.

William W., 1970. The Coral Springs Site, Southeast Florida. Florida Anthropologist 23:135-150.

Williams W. and B. Mowers, 1979. Bishop Hammock, Broward County, Florida. Florida Anthropologist 32:17-32.

Willis, R., 1979. Amax Pine Level Survey--An Archaeological and Historical Survey of Amax Properties in Manatee and DeSoto Counties, Florida. Environmental Science and Engineering, Gainesville.

Witt, D., 1976. Bowling Green Occupied by Two Families in Middle 1800s. The Herald-Advocate, July 1, 1976, pp. 4-6.

Wood, L., 1976. An Archaeological and Historical Survey of the C.F. Industries, Inc. Property in Northwestern Hardee County, Florida. University of South Florida Archaeological Report No. 2.

TABLE 9-1

POPULATION ESTIMATE AND PROJECTIONS

1980 - 2220

COUNTY	ESTIMATE	YEAR						
	JULY 1, 1978	1980	1985	1990	1995	2000	2010	2020
HARDEE	17,827							
	Low	18,200	19,200	20,600	21,800	23,000	25,000	26,700
	Medium	18,500	20,000	22,100	23,900	25,700	28,800	31,800
	High	18,700	20,800	23,600	26,100	28,500	32,600	36,100
POLK	284,388							
	Low	290,800	310,500	333,000	352,600	372,400	404,400	431,700
	Medium	296,900	326,100	360,000	389,300	418,600	469,600	517,800
	High	301,400	340,200	386,400	427,100	467,800	534,300	591,400

SOURCE: University of Florida, Bureau of Economic and Business Records, Population Studies: Bulletin Number 48, Gainsville, Florida, July 1, 1978

TABLE 9-2

208 PLANNING AREA POPULATION BY COUNTY
1976 - 2000

		HARDEE	POLK
1976	Population	18,319	275,078
1980	Population	21,900	318,600
	Change	19.5%	15.8%
1985	Population	25,300	360,300
	Change	13.0%	10.6%
1990	Population	28,600	398,300
	Change	13.0%	10.6%
1995	Population	32,000	435,100
	Change	10.6%	9.2%
2000	Population	35,500	470,400
	Change	10.9%	8.1%

SOURCE: 208 STUDY

TABLE 9-3

POPULATION BY 201 FACILITIES PLANNING AREA
1975 - 2000

AREA	1975	1980	1985	1990	1995	2000
Hardee County (Total)						
Permanent	18,500	21,900	25,300	28,600	32,100	35,500
Transient	185	219	253	286	320	355
Tourist	370	558	633	714	804	888
Total	19,055	22,677	26,186	29,600	33,224	36,743
Polk County						
Bartow						
Permanent	21,500	22,429	23,330	24,183	25,011	25,890
Transient	2,500	2,608	2,712	2,811	2,907	3,009
Tourist	534	568	603	638	673	710
Total	24,534	25,605	26,645	27,632	28,591	29,609
Fort Meade						
Permanent	7,700	7,851	7,998	8,138	8,275	8,420
Transient	1,000	1,019	1,038	1,056	1,073	1,091
Tourist	29	29	64	84	89	78
Total	8,729	8,899	9,100	9,258	9,437	9,600
Frostproof						
Permanent	7,500	8,207	8,884	9,519	10,128	10,769
Transient	1,700	1,860	2,013	2,156	2,293	2,328
Tourist	29	58	116	174	232	290
Total	9,229	10,125	11,013	11,849	12,653	13,497
Lake Wales						
Permanent	23,000	26,495	29,688	32,515	35,044	37,483
Transient	4,500	5,183	5,807	6,359	6,853	7,329
Tourist	1,537	1,769	2,036	2,349	2,706	2,975
Total	29,037	33,447	37,531	41,223	44,603	47,787
Total Polk County						
Permanent	269,550	309,484	348,056	384,592	419,452	455,697
Transient	43,100	49,462	55,602	61,419	66,974	72,750
Tourist	23,844	26,030	28,432	30,857	32,811	35,029
Total	336,494	384,976	432,090	476,868	519,237	563,476

Population Definitions

Permanent:	Reside in the county for at least one continuous year.
Transient:	Visit or reside in the county for longer than 30 days but less than one year. Generally comprised of migrant workers and winter residents.
Tourist:	Visit or reside in the county for less than 30 days per year.

SOURCE: Central Florida Regional Planning Council Estimates of Permanent Residents by University of Florida, "Population Studies" Bulletin No. 33, Bureau of Economic and Business Research, June 1975.

TABLE 9-4

HOUSEHOLD SIZE AND TYPE

	1960[1]	1970[1]	1976[2]	1980[2]	1995[2]	1960[1]	1970[1]	1976[2]	1980[2]	1995[2]
Persons Per Household	3.33	3.36	3.33	3.31	3.20	3.29	3.05	2.88	2.76	2.45
% of One Person Households	13.2	15.2	16.4	17.2	19.5	11.8	17.0	20.8	22.0	24.3

SOURCE: 1 - U.S. CENSUS OF HOUSING

2 - ESTIMATES BY ROY F. WESTON, INC. FOR CENTRAL FLORIDA REGIONAL PLANNING COUNCIL

TABLE 9-5

LAND USE BY COUNTY

	HARDEE - 1976[1]		POLK - 1978 [2]	
	Acres	Percentage	Acres	Percentage
Developed Lands	3764	1.0	136,200	10.4
Mined Lands & Reserves	128*	Min.*	224,000	17.1
Agricultural	168,801	42.7	551,200	42.0
Citrus	(66,320)	(16.8)	(200,200)	(15.3)
Pasture/Crops	(102,481)	(25.9)	(351,000)	(26.7)
Water (Lakes, Rivers)	947	0.2	112,000	8.5
Miscellaneous Vacant	221,750	56.1	287,320	22.0
Total	395,390	100	1,310,720	100.0

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* Does not include reserves

SOURCES: [1] CENTRAL FLORIDA REGIONAL PLANNING COUNCIL ESTIMATES

[2] POLK COUNTY TAX RECORDS, 1978 AND POLK COUNTY PLANNING DEPARTMENT

TABLE 9-6

PUBLIC PROTECTION AND HEALTH STATISTICS BY COUNTY

	County	Unincorporated Areas per 1000 Pop.	Total	Municipal Areas per 1000 Pop.	Total	County Areas per 1000 Pop.	County Area Total
FIRE FIGHTERS							
VOLUNTEERS							
	Hardee	-	-	-	44	-	44
	Polk	-	550	-	221	-	771
PAID							
	Hardee	-	-	-	8	-	8
	Polk	-	18	-	230	-	248
TOTAL							
	Hardee	-	-	7.65	52	2.84	52
	Polk	3.75	568	3.65	451	3.70	1019
LAW ENFORCEMENT OFFICERS							
	Hardee	2.86	33	2.21	15	2.62	48
	Polk	3.96	600	2.75	339	3.41	939
MEDICAL DOCTORS							
	Hardee	-	-	-	-	0.76	14
	Polk	-	-	-	-	1.31	361
OSTEOPATHS							
	Hardee	-	-	-	-	0	0
	Polk	-	-	-	-	0.01	3
CHIROPRACTORS							
	Hardee	-	-	-	-	0.05	1
	Polk	-	-	-	-	0.12	34
HOSPITAL BEDS							
	Hardee	-	-	-	-	3.33	61
	Polk	-	-	-	-	6.77	1862

SOURCE: EPA, 1978

TABLE 9-7

HOUSING STATISTICS

		HARDEE	POLK
1960	Units[1]	4,063	64,116
	Persons per Unit	3.03	3.03
1970	Units[1]	4,801	80,502
	Persons per Unit	3.12	2.86
1973	Units[1]	6,002	97,713
	Persons per Unit	2.85	2.63
Percent Average Yearly Increase in Housing Units			
	60 - 70	1.8	2.6
	70 - 73	7.7	6.6
1970 Housing Quality			
	Average Value	8,561	12,027
	Percentage Substandard[2]	11.9	6.0

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[1] Units include unoccupied housing and units that may be occupied only part of the year.

[2] Lacking some or all plumbing facilities.

SOURCE: UNIVERSITY OF FLORIDA (1970, 1975, 1976)
U.S. BUREAU OF CENSUS (1960, 1970)

TABLE 9-8

LABOR FORCE ESTIMATES
HARDEE COUNTY, POLK COUNTY, FLORIDA, AND UNITED STATES
1967 - 1978

Year	HARDEE		POLK		FLORIDA	UNITED STATES
	Civilian Labor Force	Unemployment Rate	Civilian Labor Force	Unemployment Rate	Unemployment Rate	Unemployment Rate
1967	4,300	1.9	92,200	3.6	2.8	3.8
1968	4,380	4.6	89,700	4.9	2.8	3.6
1969	4,580	3.1	89,600	4.1	2.5	3.5
1970	8,438	3.1	89,621	4.4	4.3	4.9
1971	6,889	4.7	91,861	6.0	4.9	5.9
1972	7,694	5.2	93,467	7.2	5.1	5.6
1973	7,243	2.6	99,234	4.5	4.3	4.9
1974	7,268	4.7	109,600	5.5	6.2	5.6
1975	6,927	3.9	110,299	7.2	10.7	8.5
1976	6,697	4.7	112,859	7.4	9.0	7.7
1977	7,274	5.3	114,276	8.4	8.2	7.0
1978	7,796	6.1	124,654	6.8	6.3	6.2

SOURCE: FLORIDA DEPARTMENT OF COMMERCE, DIVISION OF EMPLOYMENT SECURITY.

TABLE 9-9

EMPLOYMENT BY INDUSTRY

HARDEE COUNTY, POLK COUNTY, FLORIDA, AND UNITED STATES
1976

	HARDEE		POLK		FLORIDA		UNITED STATES	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
TOTAL EMPLOYMENT	6,055		115,585		3,346,442		94,657,214	
Proprietors	1,705		10,584		276,971		8,772,314	
Farm	1,173		2,771		38,052		2,850,314	
Non-Farm	532		7,813		238,919		5,922,000	
WAGE AND SALARY EMPLOYMENT	4,350	100.00	105,001	100.00	3,069,471	100.00	85,884,900	100.00
Farm	785	18.05	3,763	3.58	61,000	1.99	1,293,900	1.62
Non-Farm	3,565	81.95	101,238	96.42	3,008,471	98.01	84,990,000	98.38
Private, Non-Farm	2,601	59.79	87,435	79.46	2,304,662	76.26	66,800,000	77.78
Mining	(D)	(D)	(D)	(D)	8,566	.28	779,000	.91
Construction	89	2.05	7,093	6.76	162,993	5.31	3,617,000	4.21
Manufacturing	295	6.78	17,094	16.28	348,595	11.36	19,041,000	22.17
Trans., Comm. and Public Utilities	214	4.92	4,797	4.57	180,373	5.88	4,569,000	5.32
Trade	873	20.07	23,784	22.65	740,626	24.13	17,860,000	20.80
Finance, Insurance, and Real Estate	168	3.86	4,998	4.76	196,260	6.39	4,356,000	5.07
Services	793	18.23	17,797	16.95	675,523	22.01	16,202,000	18.86
Other	169	3.89	(D)	(D)	27,726	.90	376,000	.44
Government	964	22.16	17,803	16.96	667,809	21.76	17,690,000	20.60
Federal Civilian	42	.97	857	.82	87,587	2.85	2,876,000	3.35
Federal Military	57	1.31	896	.85	113,279	3.69	2,495,000	2.91
State and Local	865	19,89	16,050	15.29	466,943	15.21	12,319,000	14.34

NOTE: Employment is a count of jobs located in the county.
(D) Non-Disclosure Industry.

SOURCE: U.S. DEPARTMENT OF COMMERCE, BUREAU OF ECONOMIC ANALYSIS AND UNPUBLISHED DATA.

TABLE 9-10

PER CAPITA INCOME

HARDEE COUNTY, POLK COUNTY, FLORIDA, AND UNITED STATES

1966 - 1976 DOLLARS

	HARDEE		POLK		FLORIDA		UNITED STATES
	Current Dollars	Percent Of U.S.	Current Dollars	Percent Of U.S.	Current Dollars	Percent Of U.S.	Current Dollars
1966	1,922	64.0	2,457	81.9	2,585	86.1	3,001
1967	2,170	68.1	2,701	84.7	2,816	88.3	3,188
1968	2,372	68.6	2,824	81.7	3,119	90.2	3,457
1969	2,890	77.4	3,113	83.4	3,444	92.3	3,733
1970	2,809	70.8	3,352	84.5	3,738	94.3	3,966
1971	3,249	78.6	3,477	84.1	4,007	97.0	4,132
1972	3,478	77.4	3,811	84.8	4,461	99.3	4,493
1973	3,883	78.0	3,292	86.2	4,973	99.9	4,980
1974	3,882	71.5	4,720	87.0	5,338	98.3	5,428
1975	4,604	78.7	5,142	87.9	5,596	95.6	5,851
1976	4,923	77.0	5,414	84.6	6,021	94.1	6,393

NOTE: U.S. Department of Commerce per capita income date, used here to provide consistent data for interstate comparisons, are based on Bureau of the Census population estimates. Florida per capita income figures published by the State Economist's office are based on Florida Department of Administration population estimates and may vary from the per capita income figures reported in this table.

SOURCE: U.S. DEPARTMENT OF COMMERCE, BUREAU OF ECONOMIC ANALYSIS AND UNPUBLISHED DATA.

TABLE 9-11

AVERAGE WAGE AND SALARY INCOME BY INDUSTRIAL DIVISION HARDEE COUNTY, POLK COUNTY AND FLORIDA - 1977

Economic Sector	Hardee County $/yr	Polk County $/yr	Florida $/yr
TOTAL ALL INDUSTRIES	7,980	10,023	10,032
Agriculture, Forestry and Fishing	(D)	8,503	8,393
Mining	(D)	14,613	13,775
Construction	8,639	12,631	11,141
Manufacturing	7,596	12,058	11,408
Trans., Comm., and Public Utilities	11,258	12,944	14,576
Trade	6,515	7,988	8,163
Finance, Insurance, and Real Estate	9,978	9,980	10,423
Service	8,124	8,329	9,367
Government	8,385	9,766	11,436
Unclassified Industries	(D)	7,093	9,142

NOTES: Only wages for jobs covered by unemployment compensation are reported.

(D) - Non-Disclosure Industry - These numbers are included in "TOTAL ALL INDUSTRIES."

SOURCES: EMPLOYMENT SECURITY DIVISION OF THE FLORIDA DEPARTMENT OF LABOR, EMPLOYMENT AND PAYROLL DATA.

TABLE 9-12

LAND USE CLASSIFICATION OF RECLAIMED LAND
(acres)

Land Use/ Cover Classification	Existing Use	Conventional Plan	Sand/Clay Cap Plan	Sand/Clay Mix Plan	Overburden/Clay Mix Plan
Agricultural Lands	8,282	11,521	11,111	10,421	10,421
Cutover Flatwood	3,452	182	182	182	182
Upland Hardwood Forest	1,804	664	664	664	664
Upland Mixed Forest	126	1,276	1,456	1,831	1,831
Planted Pine	339	453	536	431	431
Water Areas	13	3	3	3	3
Forested Stream Channel	-	277	279	263	263
Freshwater Swamp	1,014	589	615	857	857
Freshwater Marsh	1,040	1,323	1,442	1,636	1,636
Developed	218	0	0	0	0
TOTAL	16,288	16,288	16,288	16,288	16,288

SOURCE: STUDY DATA

A. AIR QUALITY ASSURANCE

ENVIRONMENTAL PROTECTION AGENCY
REGION IV
SURVEILLANCE AND ANALYSIS DIVISION
ATHENS, GEORGIA 30601

4SA-ASB

March 15, 1979

Mr. Robert D. Stephens
Mobil Chemical Company
P.O. Box 311
Nichols, Florida 33863

Dear Mr. Stephens:

Thank you for the opportunity to review your proposed Plan of Study and Quality Assurance manual. We consider both of these to be high quality documents that if properly adhered to will result in the production of high quality data.

There are a few items we would like to comment on.

1. Section 3.2 discusses the transducer charts. These charts should be retained on file in a readily identifiable manner such as by date and site where used.

2. Section 4.1 discusses invalidated samples. Although a sample is invalidated, the filter should be retained on file along with valid samples.

3. Section 4.2 discusses hi vol filter weighing. It says that "Ten percent of the filters should be set aside for reweighing by another analyst." This has the potential for biasing the analyst in which filters are set aside and the special care of those filters. It would be better to have the other analyst choose ten percent of the filters at random.

4. Figure 5.1.1 should have a place for the signature of the technician and the date, and a place for countersigning and the date.

5. Section 6.1.4 discusses the burn-in of hi vol motors after the brushes are changed. It has been our experience that brushes are not well seated in approximately "30 minutes" especially at a reduced voltage. While the motors could be calibrated then, to do so will cause the calibration to change when the brushes do seat. This change will affect the data.

   Our suggestion is to prolong the burn-in time to like maybe overnight.

It is a pleasure to review such a document and find that private industry and contractors are working hard to collect high quality data we can all agree on.

Thank you for your cooperation.

Sincerely yours,

Doyle T. Brittain

Doyle T. Brittain
Chief

B. SOILS DESCRIPTIONS

SOIL SERIES

This Appendix presents detailed information on the 34 soil series found on the proposed South Fort Meade Mine site. Descriptions are summarized from the SCS survey. Map symbols refer to Figure 4-I.

Adamsville Fine Sand (Map Symbol 31)

Consists of somewhat poorly drained, nearly level soils occurring in south and central Florida. The surface layer is fine sand about 12 inches thick; the upper part is dark gray and the lower is dark grayish brown. Below this is a layer of grayish brown fine sand about 10 inches thick. The next layer is very pale brown fine sand about 6 inches thick. Between depths of 28 to 42 inches is white fine sand. Below this to depths of 72 inches is light gray fine sand. Slopes are less than 2 percent.

Apopka Sands (Map Symbol 2)

Consists of well drained, nearly level to steep soils that occur in central Florida. The surface layer is very dark gray sand about 6 inches thick. The subsurface layer is between depths of 6 to 55 inches. Yellowish brown sand is in the upper 34 inches, with light yellowish brown in the lower 15 inches. Below this to depths of 84 inches or more is red sandy clay loam. Slopes are generally 0 to 5 percent.

Arents (Map Symbol 68)

A clayey substratum found in old mine pits that have been covered with overburden material and contains wastes from phosphate mining. These areas are nearly level and the overburden is 2 to 4 feet thick over the clay wastes. Included in this unit are a few areas that have sand tailings over slickens. The overburden material is mostly sandy with loamy fragments or dark colored weakly cemented sandy fragments randomly mixed throughout. Slopes are 0 to 5 percent.

Basinger Fine Sand (Map Symbol 36)

Consists of poorly drained, deep sandy soils that occur in broad sloughs, poorly defined stream channels and depressions. Has a thin, very dark gray surface layer, light gray fine sand subsurface layer, and brown and light brownish gray subsoil between 18 and 36 inches. Light colored fine sand extends to below a depth of 60 inches. Slopes are less than 2 percent.

Bradenton-Bluff-Felda Association (Map Symbol 72)
This association consists of poorly and very poorly drained soils in regular and repeating patterns along streams and rivers subject to flooding. Slopes are less than 2 percent.

Bradenton Fine Sand (Map Symbol 67)
Consists of poorly drained, nearly level sandy soils that occur on low-lying ridges and hammocks in the lower coastal plain. The surface layer is very dark gray fine sand about 4 inches thick. The subsurface layer is grayish brown fine sand about 6 inches thick. The subsoil is between depths of 10 to 26 inches and is fine sandy loam; the upper 9 inches is dark gray and the lower 7 inches gray. Below this is a white and light brownish gray calcareous fine sandy loam.

Candler Fine Sand (Map Symbol 3)
Consists of excessively drained, nearly level to moderately steep soils on coastal plain uplands. These soils have a dark gray sand surface layer about 5 inches thick. Below this to depths of 67 inches is yellow sand. Between depths of 67 to 109 inches is very pale brown sand that has white mottles and yellowish brown lamellae or bands of loamy sand. Below this to depths of 115 inches is brownish yellow sandy loam. Slopes of 0 to 5 percent predominate.

Chobee Clay Loam (Map Symbol 24)
Consists of very poorly drained soils occurring in small to large depressions on low or nearly level areas. A black fine sandy loam surface layer about 7 inches thick exists, with a black to dark gray sandy clay loam subsoil containing calcium carbonate nodules. Slopes are less than 2 percent.

Electrica Fine Sand (Map Symbol 38)
Consists of somewhat poorly drained, nearly level soils occurring on slight ridges in the flatwoods areas of the lower coastal plain of Florida. These soils have a thin gray surface horizon and light gray or white subsurface

layers to a depth of 41 inches. Black or dark reddish brown weakly cemented layers occur between depths of 41 to 50 inches. A brown sand layer occurs between depths of 50 to 54 inches, and below this to 72 inches or deeper, grayish mottled loamy subsoils are present. Slopes are 0 to 8 percent.

Felda Fine Sand (Map Symbol 42)
Consists of poorly drained soils that occur in depressions and poorly defined stream channels. They formed in unconsolidated sandy and loamy marine sediments. The surface layer is black fine sand about 4 inches thick. The subsurface layers are grayish brown with light gray fine sand 18 inches thick. The subsoil is gray sandy loam about 10 inches thick. Below it is a loamy fine sand and fine sand. Slope gradients are less than 2 percent.

Felda Variant Fine Sand (Map Symbol 71)
Consists of poorly drained, gently sloping soils in central Florida. The surface layer is black fine sand about 6 inches thick. The subsurface layer is gray fine sand in the upper 7 inches, dark grayish brown cobbly fine sand in the middle 6 inches and brown cobbly fine sand in the lower 19 inches. The subsoil is light brownish gray loam about 42 inches thick. Slopes are 0 to 5 percent.

Floridana Mucky Fine Sand (Map Symbol 19)
Consists of very poorly drained soils occurring in depressions and on broad low flats. Surface soil is a black sand about 12 inches thick. A grayish brown sand subsurface layer overlies a dark gray sandy clay loam subsoil beginning within a depth of 20 to 40 inches below the soil surface. These soils formed in sandy and loamy marine sediments. Slopes are less than 2 percent.

Fort Meade Loamy Fine Sand (Map Symbol 20)
These soils in central Florida are well drained, nearly level to gently sloping. The surface layer is loamy sand about 13 inches thick. The upper 7 inches are very dark gray and the lower 6 inches are very dark grayish brown. The underlying layers are loamy sand to depths of 80 inches or more. The upper 5 inches are dark brown; the next 5 inches are dark yellowish brown, and the lower 56 inches are yellowish brown. Slopes range from 0 to 5 percent.

Holopaw Fine Sand (Map Symbol 33)
Consists of poorly drained, nearly level soils in south and central Florida. The surface layer is typically a very dark gray sand about 7 inches thick with the subsurface extending to depths of 45 inches. There is grayish brown sand in the upper 11 inches, coarsely mottled gray and grayish brown sand in the next 17 inches, and gray sand in the next 10 inches. The subsoil is between depths of 45 to 62 inches and is gray sandy loam, underlain by gray loamy sand. Slopes range from 0 to 2 percent.

Hontoon Muck (Map Symbol 35)
Occurs in freshwater swamps and marshes and consists of nearly level, very poorly drained organic soils. The surface layer is dark reddish brown partially decomposed organic matter. The subsurface layers are black and dark reddish brown organic matter which are well decomposed and about 55 inches thick. The substratum is black mucky sand to below a depth of 65 inches. Slope gradients are less than 2 percent.

Immokalee Fine Sand (Map Symbol 21)
Consists of poorly drained sandy soils with a weakly cemented spodic horizon below a depth of 30 inches. They occur on the lower Atlantic and Gulf coastal flatwoods and formed in sandy marine sediments. The surface layer is very dark gray fine sand 6 inches thick. Next are 6 inches of light gray fine sand, and then 23 inches of white fine sand. Between 35 and 54 inches are weakly cemented black and dark reddish brown fine sand. Brown fine sand extends to below 80 inches. Slope gradients are 0 to 5 percent.

Lochloosa Fine Sand (Map Symbol 26)
Occurs primarily in the central part of Florida and consists of somewhat poorly drained, nearly level to sloping soils. These soils have dark gray sandy surface horizons about 7 inches thick. Very pale brown and pale brown sandy subsurface horizons occur about 21 inches thick. Subsoil layers are yellowish brown fine sandy loam and sandy clay loam in the upper 7 inches, and gray sandy clay loam and sandy clay in the remainder of the subsoil. Slopes range from 0 to 8 percent.

Manatee Loamy Fine Sand (Map Symbol 48)

Consists of very poorly drained, nearly level soils occurring in depressions and stream channels of the lower coastal plains. The surface layer is black loamy fine sand about 18 inches thick with a moderate to high content of organic matter. The upper 6 inches of the subsoil are very dark grayish brown fine sandy loam and the remainder of the subsoil are dark gray fine sandy loam. Between depths of 48 to 60 inches is light gray fine sandy loam.

Myakka Fine Sand (Map Symbol 17)

Consists of poorly drained sandy soils that have a weakly cemented spodic horizon within 30 inches of the surface. This series is found on lower Atlantic and gulf coastal flatwoods, and was formed in sandy marine sediments. The surface layer is black sand about 6 inches thick. Below this are 14 inches of white sand. Between 20 and 56 inches are black weakly cemented sand that becomes reddish brown and dark brown and friable with depth. Below 56 inches is dark grayish brown sand to a depth of more than 80 inches. Slopes range from 0 to 2 percent.

Ona Fine Sand (Map Symbol 23)

Consists of nearly level, poorly drained sandy soils that occur in the flatwoods on the low coastal plains. The surface layer is very dark gray fine sand about 6 inches thick. A weekly cemented layer is found between depths of 6 to 20 inches. The upper 4 inches are very dark brown and the lower 10 inches are black. Below this to depths of 82 inches is grayish brown or white sand. Slopes range from 0 to 2 percent.

Paisley Variant Fine Sand (Map Symbol 44)

Occurs in low broad coastal plain areas primarily in the central part of Florida and consists of poorly drained, nearly level soils. These soils have very dark gray sand surface horizons about 5 inches thick. Dark gray or gray clayey subsoils mottled with shades of yellow or brown occur to depths of 69 inches. Below this is mottled gray and yellowish brown clayey material. Slopes are less than 1 percent.

Pits - Dumps Complex (Map Symbol 11)
Consists of overburden material (material removed to get to "matrix" material or phosphate bearing strata) piled into mounds or narrow ridges with very steep sides separated by narrow pits that may nor may not contain water.

Placid Fine Sand (Map Symbol 25)
This series occurs in central and south Florida and consists of very poorly drained, nearly level soils. The surface layer is fine sand about 20 inches thick. It is black in the upper 10 inches and very dark gray in the lower 10 inches. Between depths of 20 to 30 inches is gray fine sand. The next layer is grayish brown fine sand about 18 inches thick. Below this to depths of 80 inches or more is dark grayish brown find sand. Slopes are less than 2 percent.

Pomello Fine Sand (Map Symbol 22)
Consists of moderately well drained sandy soils occurring in low ridges on the lower coastal plain. These soils have formed in marine sands. A gray fine sand surface layer about 4 inches thick and a white subsurface layer about 58 inches thick occurs. Between a depth of 42 and 54 inches is dark reddish brown nearly cemented fine sand. Below 54 inches is brown to light gray fine sand. Slopes are 0 to 5 percent.

Pomona Fine Sand (Map Symbol 7)
Occurs in the flatwoods of hyperthermic region of the coastal plains and consists of poorly drained, nearly level soils. These soils have a very dark gray sand surface horizon underlain to a depth of about 26 inches by layers of gray or light gray sand. Below this to 36 inches are layers of very gray sand that are weakly cemented. Between depths of 36 to 51 inches are layers of brownish sand. Below 51 inches to 72 inches and deeper are layers of gray sandy clay loam or light sandy clay.

Pompano Fine Sand (Map Symbol 30)
Consists of poorly drained, nearly level soils in south and central Florida. The surface layer is dark gray fine sand in the upper 5 inches and grayish brown fine sand in the next 9 inches. Between depths of 16 to 30 inches is a

very brown fine sand. Below this to depths of 75 inches or more is fine sand. Slopes range from 0 to 2 percent.

Quartzipsamments (Map Symbol 12)
Quartzipsamments consist of sand tailings from phosphate mining that have been leveled to 0 to 5 percent slopes, with or without clay wastes added. Sand tailings are the extracted and discarded sand portion of the matrix. Phosphate companies have attempted to add fines to some of the sand tailings by pumping clay wastes onto the tailings. The amount of fines is highly variable and occur as irregular bands about 0.4 to 0.8 inches thick.

Samsula Muck (Map Symbol 13)
Occurs in freshwater swamps and marshes and consists of nearly level, very poorly drained organic soils. The uppermost 9 inches are black muck. The subsurface layer is dark reddish brown muck to a depth of 36 inches. This is underlain by 10 inches of dark grayish brown sand and then gray sand to below a depth of 55 inches. These soils formed in hydrophytic plant remains. Slope gradients are less than 2 percent.

Slickens (Map Symbol 57)
Slickens are areas of clay settling ponds. The clay wastes are the fine textured material remaining after the phosphate has been removed from the matrix, and are approximately 5 percent solids and 95 percent water. These wastes are pumped into fairly large settling ponds ranging in size from 300 to 1000 acres. The solids are principally clay (about 88 percent) with montmorillonite as the dominant clay mineral. The dikes around the holding ponds are constructed so that the residual wastes can be relatively easily dewatered.

Sparr Fine Sand (Map Symbol 14)
Consists of somewhat poorly drained, nearly level to sloping soils. They are located on uplands in the coastal plain within the central and southern peninsula of Florida. These soils usually have sandy horizons about 48 inches thick and loamy subsoils that contain plinthite. They are yellowish brown in the upper part and gray in the lower part. The subsoil extends to depths of about 100 inches. Slopes are 0 to 5 percent.

Tavares Sand (Map Symbol 15)
Occurs primarily in central and south Florida and consists of moderately well drained, nearly level to sloping soils. These soils have a very dark grayish brown surface layer about 7 inches thick underlain by layers of very pale brown and light yellowish brown sand to depths of about 61 inches. White sand occurs between depths of 61 to 99 inches. Slopes range from 0 to 5 percent.

Tomoka Muck (Map Symbol 32)
Occurs in south and central Florida and consists of very poorly drained, nearly level soils. The soil is muck to a depth of 27 inches. The upper 5 inches are very dark brown, the next 8 inches dark reddish brown, and between depths of 13 to 27 inches it is black. Below this is a layer of very dark gray sand about 4 inches thick, then a layer of gray sand about 4 inches thick. Between depths of 35 to 46 inches is dark gray sandy clay loam underlain by gray sand loam. Slopes are less than 2 percent.

Wauchula Fine Sand (Map Symbol 40)
Occurs on low ridges and in depressions in flatwoods areas and consists of nearly level, poorly drained soils. The surface layer is black and very gray fine sand about 7 inches thick overlying gray fine sand subsurface layers. Black and dark reddish brown weakly cemented fine sand layers are next and are within depths of 30 inches. Gray fine sandy loam and sandy clay loam layers are within depths of 40 inches. Slopes may range to 5 percent but slopes of 9 to 2 percent predominate.

Zolfo Fine Sand (Map Symbol 47)
Consists of somewhat poorly drained soils that formed in thick sandy marine sediments. They occupy nearly level landscapes slightly higher than the adjacent flatwoods of lower coastal plains in peninsula Florida. They have a thin grayish brown surface layer and thick light grayish brown and very pale brown subsurface layers extending to depths of about 62 inches. Below this are organic coated layers of dark reddish gray and dark reddish brown fine sand.